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THE
Ship-Builder's Aſſiſtant;
OR,
Marine Architecture.

CONTAINING

I. The Method of Extracting the Square and Cube ROOTS, GEOMETRY and MENSURATION: Wherein all the RULES neceſſary for meaſuring PLANK, TIMBER, and finding the TUNNAGE of SHIPS, are laid down in a very plain and conſpicuous Manner; and illuſtrated by proper Examples.

II. Obſervations on the Nature and Value of TIMBER; with a New METHOD of procuring it in the neceſſary FORMS for SHIP-BUILDING.

III. The Method of Drawing the PLANS of SHIPS, and moulding their TIMBERS; together with all the practical RULES neceſſary to be obſerved in Building the HULLS of all Sorts of SHIPS. To which is added, the SCANTLING or MENSURATION of SHIPS TIMBERS.

IV. Directions for making the MASTS and YARDS of a juſt Proportion to the SHIP, and alſo to one another, both with regard to Length and Thickneſs. With TABLES of the WEIGHTS and SIZES of ANCHORS and CABLES, according to the New Eſtabliſhment.

V. The BOATSWAINS ART: Shewing the METHOD of finding exactly the Length and Thickneſs of every ROPE; Alſo CABLE and CORDAGE TABLES, ſhewing by Inſpection the WEIGHT of any ROPE, whoſe Length and Thickneſs are given. With ſome Directions for Cutting out SAILS.

The Whole illuſtrated with a great Variety of FIGURES and DRAUGHTS, Engraven on COPPER-PLATES.

By WILLIAM SUTHERLAND,
Shipwright and Mariner.

LONDON:
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PREFACE.

THE Advantages flowing from Shipping, are ſo great and conſpicuous, eſpecially to the Inhabitants of theſe Kingdoms, that it would be ſuperfluous to advance Arguments in Favour of the Art of SHIP-BUILDING, or MARINE ARCHITECTURE; and therefore whatever has the leaſt tendency to its Advancement, certainly merits Encouragement. It ſhould alſo be remembered, that every Improvement made in an Art of ſuch Importance to Society, adds a farther Security to the Power, Strength, and Intereſt of theſe Kingdoms.

Animated with this pleaſing Proſpect, and alſo with a deſire of inſtructing Young SHIPWRIGHTS, and thoſe Gentlemen who are deſirous of being acquainted with theſe ſurprizing Fabrics, the AUTHOR has compiled the following Treatiſe; in which he has endeavoured to lay every Thing down in the moſt plain and perſpicuous Manner, and flatters himſelf that he has, in ſome Degree, ſucceeded.

With regard to the ſeveral Particulars treated of in this WORK, the Reader will find them immediately after this Preface, and therefore it would be ſuperfluous to enumerate them here. But it may not be improper to obſerve, that in order to render this WORK more generally Uſeful, the AUTHOR has added the Manner of proportioning the MASTS, YARDS, RIGGING, &c. and calculated ſeveral TABLES for that Purpoſe, to render it more Eaſy to the Reader. So that it will be equally uſeful to SHIPWRIGHTS, BOATSWAINS, and MARINERS.

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Marine

Marine Architecture:

OR THE

Complete Shipwright.

CHAP. I.

Of EVOLUTION, *or the Method of extracting* ROOTS.

A Root is a Number, by whoſe continual Multiplication into itſelf another Number, called a Power, is produced.

A Power therefore is a Number produced by the Multiplication of a Root into itſelf continually, a certain Number of Tines. Thus if any Number, as 2 for Inſtance, be multiplied into itſelf, the Products are 4, 8, 16, *&c.* For $2 \times 2 = 4$. $2 \times 2 \times 2$, or $4 \times 2 = 8$, and $2 \times 2 \times 2 \times 2$, or $8 \times 2 = 16$. In this Example 2 is the Root of the Products 4, 8, 16, which are called the Powers of that Root.

Hence it is evident that Power and Root are relative things. Every Power is the Power of ſome Root, and every Root is the Root of ſome Power: So that by calling one Number the Power or Root of another, we mean that it is the Number produced, or the Number producing that other by continual Multiplication. — But the ſeveral Powers and the Root with relation to theſe are alſo diſtinguiſhed by particular Names. Thus, The firſt Product, or that of the Root multiplied by itſelf, is called the Square of the Number multiplied; which, in reſpect of the other, is called the Square Root. Thus, for Example, 4 is the Square of 2, and 2 is the Square Root of 4, becauſe 2 × 2 = 4.

The ſecond Product, or that of the Square by the Root, is called the Cube, and the Root in reſpect of it, is called the Cube Root: Thus 8 is the Cube of 2, and 2 is the Cube Root of 8; for 2 × 2 × 2, or 4 × 2 = 8.

The Ancients had alſo particular Names for others of the Powers, and which have been retained by ſeveral of the Moderns, as the Biquadrate, or fourth Power; the Surſolid, or fifth Power; the Square Cubed, or ſixth Power; the ſecond Surſolid, or ſeventh Power; the Biquadrate ſquared, or eighth Power, *&c.* but being very complex and burthenſome to the Memory, we ſhall not trouble the Reader with any farther Account of them; and the rather as they have no tendency either to improve or facilitate the Science. For it is evident we have no more to do, than to diſtinguiſh them by their Order in the Series of Products, calling the firſt Product the firſt Power, the ſecond Product the ſecond Power, and ſo on. By purſuing this Method, theſe Names themſelves diſtinguiſh, in a very conſpicuous manner, the ſeveral Powers; for they expreſs the Number of Multiplications of the Root in the Production of each Power; which the Ancient Names do not.

Having given the Reader this general Idea of Roots and Powers, we ſhall now proceed to the Method of extracting the Square Root out of any Power propoſed.

Of the EXTRACTION *of the* SQUARE ROOT.

In Order to perform this Operation, the Figures in the given Number muſt be diſtinguiſhed, as long as poſſible, into Periods of two Figures, by Points placed over them, beginning thoſe Points at the Place of Unity, and aſcending towards the Left-hand if the given Number be Integers; and deſcending towards the Right-hand when it conſiſts of Decimals.

Thus for Inſtance, if the Number 7854382, were given to to have its Square Root extracted, it muſt be pointed in the following Manner.

$\dot{7}8\dot{5}4\dot{3}8\dot{2}$.

The given Number being thus pointed, the Number of Points ſhews us how many Figures the Root conſiſts of. Thus in the Example above, becauſe the given Number conſiſts of four Points, of Periods of two Figures each; therefore the Root, when extracted, will alſo conſiſts of four Figures.

Having truly pointed the given Number, or as it is generally called, the Reſolvend, we muſt proceed to find the greateſt Square contained in the firſt Period towards the Left-hand, placing its Root like a Quotient figure in Diviſion; this Square muſt be placed under the ſaid Period in the Reſolvend, and ſubtracted from it, as in common Diviſion: To the Remainder bring down the next Period of Figures for a Dividend, and double the Root of the firſt Square for a Diviſor, enquiring how often it may be had in that Dividend, except the Right-hand Figure. Place the Anſwer in the Root, and alſo on the Right of the Diviſor. Multiply this increaſed Diviſor by the laſt Figure in the Root; ſubtract the Product from the Dividend, and bring down the next Period of Figures for another New Dividend, proceeding in the ſame manner as before directed, till he whole Operation is finiſhed.

An Example or two will render the Whole very eaſy to be underſtood.

Example 1. Let it be required to extract the Square Root out of 2046114756. This Reſolvend being pointed according to the above Directions, will ſtand in the following Manner.

		$2\dot{0}4\dot{6}1\dot{1}4\dot{7}5\dot{6}$(45234 The Root.
		16 = the greateſt Square in 20.
1ſt Diviſor,	85)	446
	5	425
2d Diviſor,	902)	·2111
	2	1804
3d Diviſor,	9043)	·30747
	3	27129
4th Diviſor,	90464)	·361856
		361856
		······

Example 2. Let the Square Root of 1850701764025 be required.

OPERATION.

```
         . . . . . . .
         1850701764025(1360405
          1
23)       ·85
 3         69
266)      1607
  6       1596
27204)  ··110176
    4     108816
2720805)  ··13604025
              13604025
              ........
```

Hence it appears that 1360405 is the Square Root of 1850701764025.

Example 3. What is the Square Root of ,15241383936, Decimal Parts?

OPERATION.

```
         , . . . . . .
         ,15241383936(,123456, the Root required.
          1
22)        ·52
 2          44
243)       ·841
  3        729
2464)     11238
   4       9856
24685)    138239
    5     123425
246906)  ·1481436
          1481436
          .......
```

In the above Examples the Numbers given have been perfect Squares, and therefore their Roots have been extracted without leaving any Remainder; but it generally happens otherwiſe; that is, the Reſolvend is not a perfect Square. When this is the Caſe, ſomething will remain after the Extraction is finiſhed. Numbers of this kind are called Surds, and their Roots can never be truly found. Therefore when ſuch a Number is to have its Root extracted, it will be neceſſary after the Extraction has been carried through all the Points, to annex two Cyphers to the Remainder, and continue the Operation as before; by which means we can approximate towards the true Root, till we have carried it to any Degree of exactneſs required.

For Example. Let it be required to extract the Square Root out of 5844.

OPERATION.

```
           5844(76,446, nearly the Root required.
           49
 146)     ·944
   6       876
 1524)    ·68,00
    4      6096
 15284)    ·70400
     4      61136
 152886)   ·926400
            917316
           ··9084, &c.
```

From the above Example it is plain, that tho' it is impoſſible to find exactly the Square Root of 5844, yet by annexing Cyphers to the Remainders, and proceeding as before, we have found it to the one thouſandth part of an Unit; and might, by proceeding in the ſame Manner, have carried it to a much greater Degree of exactneſs.

How to prove the SQUARE ROOT.

As Extraction is oppoſite to the raiſing of Powers, ſo the one is the Proof of the other. Therefore in order to prove any Operation for extracting the Square Root, we have nothing more to do, than to multiply the Root found by the Operation into itſelf; for if the Work be truly performed, and there be no Remainder, that is, if the true Root be found, the Product will be equal to the Reſolvend, or Number out of which it was extracted. For Inſtance, we will prove the ſecond Example above, where the Root found is, 1360405

```
      1360405
      1360405
      -------
      6802025
     54416200
    81624300
  4081215
1360405
-------------
1850701764025
```

Thus we ſee that the Root 1360405, multiplied into itſelf, producees 1850701764025, the ſame with the Reſolvend, or Number given, and which proves that the Work was rightly performed. But it muſt be remembered, that when the true Root of a Number cannot be exactly found, then in order to prove the Work, the Remainder muſt be added to the Product of the Root into itſelf; and that Sum, if the Work be truly performed, will be equal to the Reſolvend, or Number given.

To EXTRACT *the* CUBE ROOT.

1. Divide the given Number into Periods of three Figures, by placing Points over them, beginning at the Right-hand Figure. Theſe Points will ſhew the Number of Figures in the Root, which will always be equal to the Number of Points.

2. Begin at the laſt Period, or that on the Left-hand, which is the firſt Reſolvend, and ſeek the greateſt Cube contained in it; ſet down its Cube Root like a Quotient in Diviſion, and place its Cube under the firſt Period; ſubtract it from the firſt Dividend, and to the Remainder bring down the next Period, which will form a ſecond Dividend.

3. Conſider the Figure found as in the place of Tens, or with 0 prefixed, and under that Value take the Triple of it, and alſo the Triple of its Square, making the Sum of theſe a Diviſor. (But as theſe are compoſed of two Parts, it will be convenient to diſtinguiſh them, by calling the Triple Square the firſt Part, and the other the ſecond Part.) Then find how often this Diviſor is contained in the Dividend laſt formed; but with this Limitation, That having multiplied the firſt Part of the Diviſor by the Figure in the Quotient, and the ſecond Part by the Square of that Figure, and laſtly, to the Sum of theſe two Products adding the Cube of the Figure found; this Sum ſhall not exceed the Dividend: Which Sum being therefore extracted out of the Dividend, and the next Period prefixed to the Remainder, a third Dividend will be found.

Take both Figures of the Root already found, and conſidering them as ſo many Tens, take the Triple of that Number, and alſo the Triple of its Square, whoſe Sum will be your next Diviſor diſtinguiſhed into firſt and ſecond Part as before; then find how often this Diviſor is contained in the Dividend laſt formed, under the ſame Limitations as before; place the Figure found on the Right of theſe already found in the Root; and ſubtracting from the Dividend, as before directed, to the Remainder prefix the next Period for a new Dividend.

Form a new Diviſor from the Figures of the Root found in the ſame Manner as in the preceeding Steps, and divide under the ſame Limitation, and proceed in this Manner till all the Periods are taken in; finding at every Step a new Figure of the Root, which in ſome Caſes will be a Cypher; as when the Diviſor is greater than the Dividend, or when 1 added to the Diviſor, the Sum becomes greater than the Dividend: In which Caſe, after placing the Cypher in the Root, bring down the next Period to the ſame Dividend; and proceed to form a new Diviſor, by prefixing another Cypher to the laſt Diviſor.

Example 1. What is the Cube Root of 614125?

OPERATION.

614125(85 the Cube Root required.
512
19440)102125
96000
6000
125
102125 Sum
...... Remainder

In the above Example the given Number being pointed according to the above Directions, the firſt Period is 614, the greateſt Cube in which is 512, whoſe Root is 8, which I place in the Root; and the Cube of it, *viz.* 512, ſubtract from 614, and the Remainder is 102; to which I bring down the next Period, *viz.* 125, and I have 102125 for a ſecond Dividend. Then to form a Diviſor, I prefix a Cypher to the Root, and then its Square will be 6400, which being multiplied by 3, the Product is 19200; then I multiply the Root, (with the Cypher prefixed) by 3, which gives 240, and this being added to 19200, I have 19440 for a Diviſor. This Diviſor, with the proper Limitation of the Rule, is contained in the Dividend 5 times, and conſequently 5 is the ſecond Figure in the Root; then having multiplied 19200, the Triple Square of the firſt Figure and Cypher, by 5 the ſecond Figure, the Product is 96000, which I place under the Dividend; then I multiply 240, the Triple of the firſt part of the Root, by 25 the Square of the ſecond Figure, and the Product 6000, I alſo place under the Dividend; and laſtly, I take the Cube of the laſt Figure, *viz.* 125, and place it under the former, and the Sum of theſe is 102125, equal to the Dividend. And therefore 85 is the true Cube Root of the given Number.

Example 2. Let it be required to extract the Cube Root of 41421736.

OPERATION.

41421736(346 the Cube Root.
27
2790)14421 2d Dividend
10800
1440
64
12304 Sum

347820)2117736 3d Dividend
2080800
36720
216
2117736 Sum
······· Remainder

The firſt Period, in the above Example is 41, and the greateſt Cube is 27, whoſe Root is 3. The ſecond Dividend is 14421, and the Diviſor, formed as in the preceding Example, is 2790; whence the ſecond Figure will be 4; the third Dividend is 2117736, and to form the ſecond Diviſor, I prefix a Cypher to the Root, and it is 340, whoſe Square is 115600, and the Triple Square 346800; alſo the Triple of 340 is 1020, which being added to 346800, gives 347820, for a ſecond Diviſor; whence the laſt Figure of the Root is 6, as is plain from the Work above.

In the above Examples the Numbers given have been perfect Cubes; but this rarely happens: ſo that after all the Periods are brought down there will be a Remainder. In theſe Caſes, the Root found according to the foregoing Inſtructions, will be the Root of the greateſt intregal Cube contained in it; but the Roots of ſuch Numbers may be approximated to any Degree of exactneſs, by annexing Periods of Cyphers thereto, and proceeding in the ſame manner, obſerving that every

Period of Cyphers will produce a Figure in the Root; but it muſt be remembered that theſe Figures are not whole Numbers, but Decimal Parts.

Proof of the Cube Root.

Involve the Root found to the Cube or third Power; that is, multiply the Root by itſelf, and then multiply that Product by the Root; if the Cube thus found be equal to the Number, from whence the Root was extracted, the Work is true, otherwiſe not. But if there be any Remainder, it muſt be added to the laſt Product, and the Sum, if the Operation be rightly performed, will be equal to the Number given.

Thus if we would know whether 85 be the true Cube Root of 614125, as in the firſt Example, we muſt involve 85 to the Cube, or third Power, in the following Manner.

85 Root
85
425
680
7225 Square, or ſecond Power.
85
36125
57800
614125 Cube or third Power; which being equal to the Number from whence the Root was extracted, ſhews that the Work was rightly performed.

CHAP. II.

Of GEOMETRY.

Sect. 1. *Definitions and Principles.*

1. GEometry is that Science which treats of the Deſcriptions, Properties, and Relations of Magnitudes in general. The Term itſelf imports no more than the Art of meaſuring the Earth, or any part of it; but it is now applied to all Magnitudes in general.

2. A Point is that which has no Parts, and conſequently is indiviſible.

3. A Line is Length without Breadth, whoſe Ends or Extremities are Points; and when it is the ſhorteſt Diſtance between two Points, it is called a Right-line; but when it is not the ſhorteſt Diſtance, it is termed a Curve-line.

4. A Superfices is that which has only Length and Breadth, being bounded or terminated by Lines.

5. A Plain-Angle is the Inclination of two Lines to each other in the ſame Plane, which touch each other, but do not both lie in the ſame Right-line.

6. If the Lines containing the Angle be right ones, the Angle is called a Right-lined Angle.

7. When a Right-line ſtanding on another Right-line makes Angles on either ſide thereof equal between themſelves, each of theſe Angles will be a right one, or equal to 90d. and that Right-line which ſtands upon the other is called a Perpendicular to that on which it ſtands.

8. But if the Right-line ſtanding on the other, be not Perpendicular to it, the two Angles formed will be unequal; that which is greater than a Right-Angle, is called an Obtuſe-Angle, and that which is leſſer an Acute-Angle.

9. A Term, Limit, or Boundary, is that which is the extreme of any thing.

10. A Figure is that which is contained under one or more Sides.

11. A Circle is a plain Figure, contained under one Line, called the Circumference; to which all Right-lines drawn from a certain Point within the Figure, are equal.

12. And that Point is called the Centre of the Circle.

13. A Diameter of a Circle is a Right-line drawn through the Centre, and terminated on both Sides by the Circumference, dividing the Circle into two equal Parts: The half of the Diameter is called the Radius.

14. A Semi-circle is a Figure contained under a Diameter, and that part of the Circumference of a Circle cut off by the Diameter.

15. A Segment of a Circle is a Figure contained under a Right-line, and the part of the Circle's Circumference cut off by that Right-line.

16. Right-lined Figures are ſuch as are contained under Right-lines.

17. Three-ſided Figures are ſuch as are contained under three Lines; and theſe are called Triangles.

18. Four-ſided Figures are ſuch as are contained under four Lines.

19. Many-ſided are thoſe contained under more than four Right-lines.

20. An Equilateral Triangle is a Figure contained under three Right-lines, all equal to one another.

21. An Iſoſeles or Equicrural Triangle, is that which hath two equal Sides.

22. A Scalene Triangle is that which hath three unequal Sides.

23. A Triangle having two Sides perpendicular to each other; or which contain a Right-Angle, is called a Right-Angled-Triangle.

24. An Obtuſe-Angled-Triangle is that which has one Obtuſe-Angle.

25. An Acute-Angled-Triangle, is that which hath three Acute-Angles.

26. A Square is a Figure contained under four equal Sides, and whoſe Angles are all right ones.

27. A Parallelogram or Oblong, is a quadrilateral or four-ſided Figure, whoſe oppoſite Sides are paralleland equal to each other, and its Angles all right ones.

28. A Rhombus is a quadrilateral Figure, having four equal ſides, but not Right-Angles.

29. A Rhomboides is a quadrilateral Figure, whoſe oppoſite Sides and Angles only are equal.

30. All quadrilateral Figures, except theſe, are called Trapezia.

31. Parallels are ſuch Right-lines in the ſame Plane, which, if infinitely produced both ways, would never meet.

32. The Diagonal, in a quadrilateral Figure is a Line drawn from one Angle to its oppoſite Angle.

33. The Baſe of a Figure is the Line it is ſuppoſed to ſtand on.

34. The Alttiude or Height of a Figure, is the perpendicular Diſtance between the Baſe and the Vertex, or Part moſt remote from the Baſe.

35. A Propoſition is ſomething propoſed to be conſidered; and requires either a Solution or Anſwer, or that ſomething be explained or proved.

36. A Problem is a practical Propoſition, in which ſomething is propoſed to be done, or effected.

37. A Theorem is a ſpeculative Propoſition, or Rule, in which ſomething is affirmed to be true.

38. A Corollary is ſome Concluſion deduced from a preceding Propoſition.

39. A Scholium is a Remark on ſome Propoſition, or an exemplification of the Matter contained in it.

40. An Axiom is a ſelf-evident Truth, or Principle, to which every one, on hearing it propoſed, muſt give his aſſent.

41. A Poſtulate is a Principle or Condition, requeſted, the reaſonableneſs of which cannot be denied.

POSTULATES.

1. That a Right-line may be drawn from any one Point to another.

2. That a finite Right-line may be continued, or lengthned at pleaſure.

3. That from a given Point, and with any Radius, a Circle may be deſcribed.

AXIOMS.

1. Things equal to one and the ſame thing, are equal to one another.

2. If to equal Things, are added equal Things, the Sums or Wholes will be equal.

3. If from equal Things equal Things be taken away, the Remainders will be equal.

4. If equal Things be added to unequal Things, the Sums or Wholes, will be unequal.

5. If equal Things be taken from unequal Things, the Remainders will be unequal.

6. Things which are double to one and the ſame Thing, are equal between themſelves.

7. Things which are half one and the ſame Thing, are equal between themſelves.

8. Things which naturally agree together are equal to one another.

9. Equal Circles have equal Radii.

Sect. II. GEOMETRICAL PROBLEMS..

PROB. 1. *To beſect or divide a Right-Line given, as* A B, *(Plate* 1. *Fig.* 1.) *into two equal parts.*

OPERATION.

1. Set one point of the Compaſſes in A, and with any Radius greater than half A B, deſcribe two Arches, one above and the other below the given Line. Then ſetting the Point of the Compaſſes in B, with the ſame Radius as before, deſcribe two more Arches, cutting the former in C and D.

2. Lay a Ruler on the Interſections of thoſe Arches at C and D, and draw the Line C D, which will divide the Line A B into two equal Parts, as was required.

PROB. 2. *From a given Point as* B *(Plate* 1. *Fig.* 2.) *in or near the middle of a given Line* A F, *to draw a Line perpendicular to the given Line.*

OPERATION.

1. Set one Point of the Compaſſes in B, open them to any convenient Radius leſs than B A or B F, and turning about the other Point, make the Marks E and C.

2. From E and C, with any convenient Radius, greater than BC or BE, deſcribe two Arches cutting each other in D.

3. From the Point B, through the Interſection of the Arches, draw the Right-line BD, which will be the perpendicular required.

PROB. 3. *From a given Point, as* B, *(Plate* 1. *Fig.* 3.) *at or near the End of a given Line* A F, *to draw another Line perpendicular to it.*

OPERATION.

1. Take at pleaſure, any convenient Point, as C, place one Foot of the Compaſſes in the ſaid Point, and extend the other to B, and with that Radius deſcribe the Arch E B D, cutting the given Line in B and D.

2. Through D and C, draw the Right-line D C E, cutting the Arch D B E in E.

3. Through B and E, draw the Right-line B E, which is the Perpendicular required.

PROB. 4. *To biſect a given Right-lined Angle, as* A B C, *(Plate* 1. *Fig.* 4.)

OPERATION.

1. Set one Foot of the Compaſſes in B, and with any convenient Radius, deſcribe the Arch A C.

2. From A and C, with one and the ſame Radius, deſcribe two Arches interſecting each other in D.

3. Draw a Right-line through B and D, which will biſect, or divide the given Angle into two equal Parts, as was required.

PROB. 5. *To draw a Line perpendicular to a given Line* A B, *(Plate* 1. *Fig.* 5.) *that ſhall paſs a given Point* C, *ſituated without the Line, and near the middle of it.*

OPERATION.

1. Set one Point of the Compaſſes in the given Point C, and with any convenient Radius, deſcribe the Arch D E, cutting the given Line in D and E.

2. From D and E, with one and the ſame Radius, deſcribe two Arches interſecting each other in F.

3. Lay a Ruler on the given Point C, and the cutting of the Arches at F, and draw the Line C G, the Perpendicular required.

PROB. 6. *To draw a Line perpendicular to a given Line* AB, *(Plate* 1. *Fig.* 6.) *that ſhall paſs thro' an aſſigned Point, nearly over the End of the given Line.*

Operation.

1. Draw from the given Point C, a Right-line at pleaſure, to cut the given Line A B, as in D.

2. Biſect the Right-line C D in E, by Prob. 1.

3. Set one Foot of the Compaſſes in E, and with the Radius E C, deſcribe the Arch C G D, cutting A B in G.

4. Through C and G, draw the Right-line C G, the Perpendicular required.

PROB. 7. *To make at a Point* D *(Plate* 1. *Fig.* 7.) *a Right-lined Angle, equal to a given Right-lined Angle* AB C.

Operation.

1. From B and D, with the ſame Radius, deſcribe the Arches A C, E F.

2. Take the Diſtance A C in the Compaſſes, and lay it on the Arch E F, from F to E.

3. Draw the Right-Lines D E, D F, which will form the Angle F D E, equal to the given Angle A B C, as was required.

PROB. 8. *To draw a Line as* D E, *(Plate* 1. *Fig.* 8.) *parallel to a given Right-line* A B.

Operation.

1. On the given Points A and B, with the Diſtance requiſite between the two Lines, deſcribe the Arches D and E.

2. Lay a Ruler to touch the top of the Arches, and by it draw the Line D E, which will be parallel to the given Line A B, as was required.

PROB. 9. *To draw a Line parallel to a given Line* A B, *(Plate* 1. *Fig.* 9.) *which ſhall paſs through a Point aſſigned, as* C.

OPERATION.

1. Set one Foot of the Compaſſes on any Point, as D, in the Line A B, and with the Radius D C, cut A B in E.

2. On E, with the ſame Radius, deſcribe the Arch F.

3. Set one Foot of the Compaſſes in C, and with the ſame Radius as before, deſcribe the Arch DF, cutting the former in F.

4. Draw thro' C and F, the Right-line C F, which will be parallel to the given Line A B, and paſs through the Point C, as was required.

PROB. 10. *Upon a given Right-line, as* AB, *(Plate* 1. *Fig.* 10.) *to deſcribe a Square.*

OPERATION.

1. Draw B C, perpendicular and equal to A B.

2. Set one Foot of the Compaſſes in B, and with the Radius B A, deſcribe the Arch D. And on C, with the ſame Radius, deſcribe the Arch B D, cutting the former in D.

3. From the Interſections of thoſe Arches draw Lines to the Points C and A; and the Figure A B C D will be the Square required.

PROB. 11. *To deſcribe a Circle, whoſe Circumference ſhall paſs thro' three given Points, as* A, B, C, *(Plate* 1. *Fig.* 11.) *provided they are not ſituated in one Right-line.*

OPERATION.

1. Biſect the Diſtance C B, with the Line D E; that is, ſet one Point of the Compaſſes in C, and with any convenient Radius, greater than half B C, deſcribe two Arches; and removing the Point of the Compaſſes to B, with the ſame Radius as before, deſcribe two other Arches, cutting the former in D and I, and draw the Right-line E D.

2. In the ſame Manner biſect the Diſtance B A, with the Line F G. Where theſe two Lines interſect each other, as at H, is the Centre of the Circle.

3. On H, the Center, with the Diſtance to either of the given Points deſcribe the Circle, which will paſs thro' the given Points, as was required.

PROB. 12. *To divide a given Line, as* AB, (*Plate* 1. *Fig.* 12.) *into any propoſed Number of equal Parts.*

OPERATION.

1. From the Extremities A and B, with the ſame Radius, deſcribe the Arches C and D; and conſequently Lines drawn from A and B to touch theſe Arches will be parallel to each other.

2. In each of the Lines A E, B F, beginning at A and B, ſet off, of any Length, as many Equal Parts leſs one, as the given Line AB is required to be divided into, *viz.* 1, 2, 3, 4, 5, 6.

3. Draw Lines from 6 to 1, 2 to 5, 3 to 4, *&c.* which will divide the given Line A B, as was required.

This Problem *may alſo be performed by the following*

OPERATION.

1. Thro' one End, as A, (*Plate* 1. *Fig.* 13.) draw a Line CC, nearly perpendicular to A B.

2. Draw at any convenient Diſtance E F parallel to A B.

3. In E F take of any Length, as many Equal Parts as A B is to be divided into; as 1, 2, 3, 4, 5, 6, to F.

4. Thro' B and F, where the Diviſions terminate, draw BC.

5. Draw Lines from C, thro' the ſeveral Diviſions of E F, which will cut A B into the Equal Parts required.

But it is neceſſary to obſerve, that if the Diviſions from E to F happen to be leſs than A B, the Point C, and the Line B F, will be on the ſame ſide of A B; but if greater, C falls on the contrary Side.

PROB. 13. *To conſtruct Scales of Equal Parts.*

OPERATION.

1. Draw three Lines, as A, B, and C, (*Plate* 1. *Fig.* 14.) parallel to one another, and at convenient Diſtances, as expreſſed in the Figure.

2. On the Line A, ſet off the Equal Parts A *b*, *b c*, *e d*, *d a*, &c. each equal to ſome propoſed Length.

3. Thro' A draw the Line D E, perpendicular to A *a*; and parallel to D E, through the ſeveral Points *b*, *c*, *d*, *a*, &c. draw Lines acroſs the three Parallels A, B, C; then are the Squares or Diſtances A *b*, *b c*, *c d*, &c. called the primary Diviſions.

4. Divide the Left-hand ſpace into 10 Equal Parts; and through theſe Points let Lines parallel to D E be drawn acroſs the Parallel B C; and the primary Diviſion A B, will be parted into 10 Equal Spaces, called Subdiviſions.

5. Number the Primary Diviſions from the Left-hand towards the Right, and the Scale is finiſhed.

Scales of this Kind are very uſeful for the Conſtruction of Figures, whoſe Sides are expreſſed in Meaſures and Length; as Feet, Yards, Miles, *&c.* Or to find the Meaſures of the Lengths of Lines in a given Figure.

Thus a Line of 36, or 360 Feet, Yards, *&c.* is taken by ſetting one Point of the Compaſſes on the third Primary Diviſion, and extending the other Point to the ſixth Subdiviſion: And ſo of others.

In theſe Scales, it is generally ſuppoſed that an Inch is divided into ſome Number, of ſuch Parts as are expreſſed by the Subdiviſions.

PROB. 14. *To find the Diviſions of a Scale of Equal Parts, when any given Number of them are to make an Inch.*

OPERATION.

1. Make a Scale C *a*, (*Plate* 1. *Fig.* 14.) where the Primary Diviſions ſhall be each one Inch; let D C be at Right-Angles to C *a*, and the Left-hand ſpace C *b*, divided into 10 Equal Parts; and draw D *b*, from any Point D.

2. Draw D H, making with D C any Angle; and make D I equal to C *b*.

3. Take the Number of Parts propoſed in an Inch, from the Scale C *a*, and ſet them off from D to *n*, on the Line D C, continued if neceſſary.

4. Draw *n* I, and C G parallel to *n* I; and make D *r* equal to D G.

5. Through *r*, draw *r s*, cutting D *b* in *t* ; then *r t* will be one of the Primary Diviſions, containing 10 of the Parts the Inch was to be divided into.

6. Lines drawn from D to the Diviſions of C *b*, graduates *r t* into 10 Equal Parts.

PROB. 15. *On a given Line, as* AB, (*Plate* 1. *Fig.* 15, 16.) *to conſtruct a regular Polygon of any aſſigned Number of Sides.*

OPERATION.

1. Divide 360 Degrees by the Number of Sides ; ſubtract the Quotient from 180 Degrees, the Remainder will be the Degrees which meaſure the Angle made by any two adjoining Sides of that Polygon, and is called the Angle of the Polygon.

2. At the Ends A, B, of the Line B A, make Angles A B C, B A D, equal to the Angle of the Polygon.

3. Make A D, B C, each equal to A B.

4. At the Points C D, make Angles equal to that of the Polygon as before ; and let the Sides including thoſe Angles be each equal to A B ; and thus proceed until the Polygon is conſtructed.

In Figures of any Number of Sides, the two laſt D E, C E, or E G, H G, are readieſt found by deſcribing Arches from C and D, or from E and H, with the ſame Radius A B interſecting in E or in G.

In Figures of an even Number of Sides, having drawn half the Number A D, A B, B C, C F, by means of the Angles ; the remaining Sides may be found by drawing through the Points D and F, the Lines D E, F H, parallel and equal to their oppoſite Sides ; and ſo of the reſt

PROB. 16. *To deſcribe an Ellipſis.*

The Ellipſis is one of the Conic Sections, and is a Figure contained within ſingle Curve Line, and having two unequal Axis or Diameters, as A B and D E. (*Plate* 1. *Fig.* 17.) The greater Axis of the Ellipſis, or the Right-line A B, repreſenting the Length of the Ellipſis, is called the Tranſverſe Axis, or Diameter ; and the leſſer Axis D E repreſenting the Breadth of the Ellipſis, the Conjugate, or Second Axis. Theſe two Diameters alſo biſect each other at Right-Angles, in C the Center of the Ellipſis.

The two Points F, *f*, in the Tranſverſe Diameter, equally diſtant from the Extremes thereof A and B, are called the Foci, or Umbilici of the Ellipſis; from which two Lines drawn to the Circumference of the Ellipſis, are equal to the Tranſverſe Diameter, or longeſt Axis.

The Right-line F E, drawn from the Focus F, to the extremity of the Conjugate Semi-axis, is equal to half the Tranſverſe Axis A C B. Hence the Conjugate Axis being given the Foci are eaſily determined. For, biſecting the greater Axis A B in C; from C erect a Perpendicular C D, equal to the Conjugate Semi-Axis; then from D, with the Interval C A, the Foci F and *f*, are determined.

Becauſe the Sum of the two Right-lines F E and *f* E drawn from each Focus F and *f* of an Ellipſis to the ſame Point of the Periphery E, is equal to the greater Axis AB, the Ellipſis, when the Conjugate Axis is given, may be eaſily deſcribed by the following

OPERATION.

Determine the Foci F and *f*, as already directed; then fixing two Nails or Pins therein, tye about them a Thread F E *f*, equal to the length of the Tranſverſe Diameter A B; apply a Style or Pin to its Extent, ſtretch the Thread, and carry the Style or Pin gently round, which will deſcribe the Curve of the Ellipſis.

Sect. III. GEOMETRICAL THEOREMS.

THEOREM 1. *When one Right-line, as* C D, *(Plate* 1. *Fig.* 18.) *ſtands upon another Right-line, as* A B, *they form two Angles* B C D, A C D, *which together are equal to two Right-Angles.*

DEMONSTRATION.

On C, as a Center, deſcribe the Semi-circle A D B. Then is the Arch D B, the meaſure of the Angle D C B; and the Arch D A the meaſure of the Angle D C A: But the Arch A D + the Arch D B, is equal to 180 Degrees, or two Right-Angles. Q. E. D.

COROLLARY.

Hence if ever ſo many Right-lines, as C D, C *d*, &c. ſtand on one Point C, on the ſame Side of another Right-line A B; the Sum of all the Angles are equal to 180 deg. or two Right-Angles.

THEOREM 2. *If two Right-lines, as* A C, E B, (*Plate.* 1. *Fig.* 19.) *interſect each other, as in* D, *the oppoſite Angles are equal,* viz. *the Angle* C D B = *the Angle* A D E, *and the Angle* C D E = *the Angle* A D B.

DEMONSTRATION.

Becauſe the Angle A D E + the Angle A D B = two Right-Angles. And the Angle C D B + the Angle A D B = two Right-Angles. Therefore the Angle A D E + the Angle A D B = the Angle C D B + the Angle A D B. Conſequently the Angle A D E = the Angle C D B.

COROLLARY.

Hence if ever ſo many Right-lines interſect each other in the ſame Point, the Sum of all the Angles formed by them about that Point is equal to 360 Degrees, or four Right-Angles.

THEOREM 3. *If a Right-line, as* F E, (*Plate* 1. *Fig.* 20.) *cut two parallel Lines, as* A B *and* C D; *the outward Angle* a *will be equal to the inward and oppoſite Angle* d; *and the alternate Angles will be alſo equal*: *and* vice verſâ.

DEMONSTRATION.

Becauſe CD and A B, are by Suppoſition, parallel; therefore F E has the ſame Inclination to C D and A B. But this Inclination is expreſſed by the Angle *a*, or the Angle *d*. Conſequently the outward Angle *a*, is equal to the inward and oppoſite Angle *d*. But the Angle *a* is equal to the Angle *c*; and the Angle *a* is equal to the Angle *d* (by the preceeding Theorem.) Conſequently the alternate Angles *c* and *d* are equal.

THEOREM 4. *In any Right-lined Triangle, as* A B C, (*Plate* 1. *Fig.* 21.) *the Sum of the three Angles,* a, b, c, *is equal to* 180 De-

180 *Degrees, or two Right-Angles. And if one ſide of the Triangle, as* B C, *be continued, the outward Angle* f, *will be equal to the Sum of the two inward and oppoſite Angles* a *and* b.

DEMONSTRATION.

Draw, through the Point A, a Right-line parallel to B C. Then will the Angle e + the Angle a + the Angle d, $= 180$ Degrees, or two Right-Angles. And by the laſt Theorem, the Angle $e =$ the Angle b; and the Angle $d =$ the Angle c. Therefore the Angle b + the Angle a + the Angle $c =$ the Angle e + the Angle a + the Angle d. Conſequently the Angle b + the Angle a + the Angle $c = 180$ Degrees, or two Right-Angles. Alſo becauſe the Angle c + the Angle $f =$ 180 Degrees. Therefore the Angle $f =$ the Angle a + the Angle b.

COROLLARIES.

1. Hence the two Acute Angles of every Right-angled Triangle are equal to 90 Degrees; and therefore if one of them be given, the other is alſo known, being equal to the Complement of the other, or what the other is leſs than a Right-Angle.

2. The Sum of three Angles of any Triangle is equal to the Sum of the three Angles of any other Triangle.

3. If one Angle of any Plane Triangle be given, the Sum of the other two Angles is known, being equal to the Difference between the given Angle, and 180 Degrees.

THEOREM 5. *Parallelograms, as* A D, D *a*, (*Plate* 1. *Fig.*22.) *ſtanding on the ſame Baſe, as* C D, *or equal Baſes, and between the ſame Parallels, as* A *b*, C E, *are equal.*

DEMONSTRATION.

Becauſe A B $=$ C D $= a\,b$; therefore A $a = $ B b, for B a is common to both. And becauſe A C $=$ B D, as the Angle A $=$ the Angle C, therefore the Triangle A C $a =$ the Triangle B D b; and if from both the Triangles there be taken the Triangle B x a, common to both, there will remain the Trapezium A B x C $=$ the Trapezium $a\,b\,x$ D. But the Trapezium A B x C + the Triangle C x D = the Parallelogram A B C D. And the Trapezium $a\,b\,x$ D + the Triangle C x D = the Parallelogram $a\,b$ C D. Conſequently the Parallelogram A B C D = the Parallelogram $a\,b$ C D.

COROLLARY.

Hence all Triangles ſtanding upon the ſame Baſe, or upon equal Baſes, and between the ſame Parallels are equal. For all Triangles are the Halves of their circumſcribing Parallelograms; and therefore if the Wholes are equal their Halves will be alſo equal.

THEOREM 6. *In any Right-angled Triangle, as* A B C, (*Plate* 1. *Fig.* 23.) *the Square of the Hypotenuſe, as* A C, *is equal to both the Squares of the Sides including the Right-Angle, as* A B, BC.

DEMONSTRATION.

Draw a Square, whoſe Side is A C, a Square whoſe Side is B C, and a Square whoſe Side is A B. Join B D, B E, A I and C F, and draw B M parallel to C E.

Then the Angle D A C = the Angle F A B. And by adding the Angle B A C, common to both, the Angle B A D = the Angle F A C. Alſo, becauſe A B = A F, and A D = A C, by conſtruction; therefore the Triangle B A D = the Triangle F A C. But the Parallelogram A M = twice the Triangle B A D (*by Cor. to Theorem* 5.) and (by the ſame) the Square A G = twice the Triangle A F C. Conſequently the Parallelogram A M = the Square A G.

And in the ſame Manner it may be proved that the Parallelogram C M = the Square C H. Therefore the Square A E = the Parallelogram A M + the Parallelogram C M = the Square A G + the Square C H.

COROLLARY.

Hence from two given Sides of a Right-angled Triangle it will be eaſy to find the third; for if the two Sides containing the Right-Angle are given, the Hypotenuſe, or Side ſubtending the Right-Angle will be found by adding the Squares of the two given Sides together, and extracting the Square Root out of that Sum. Or if the Hypotenuſe, and one of the Legs be given, the Square of the given Leg being ſubtracted from the Square of the Hypotenuſe, the Square Root of the Remainder will be the Leg required.

CHAP. III.

Of MENSURATION.

Sect. I. MENSURATION *of* SUPERFICIES.

PROB. 1. *To find the Area of a Square, or Right-angled Parallelogram.*

RULE.

Multiply the Length by the Breadth, and the Product will be the Area required.

Example 1. *Suppoſe in the Square* g h i k, (*Plate* 2. *Fig.* 1.) *that* g h, g k, h i, k i, *are all equal, and each contain* 120 *Inches; what is the Area of the Square?*

OPERATION.

Multiply ———— 120 the Length,
By ————— 120 the Breadth.

2400
120

14400 the Content required.

And becauſe 144 Inches are equal to one Square Foot (for 12 × 12 = 144;) therefore if the Area found above in Inches be divided by 144, the Quotient will give the Area in Feet, and Remainder the odd Inches.

By this Rule all ſtrait Boards, whoſe Breadths at each End are equal, may be meaſured. But if broader at one End than at the other, it will be neeeſſary to take the Breadth at both Ends, add them together, and take the Half for the true Breadth.

It will alſo be neceſſary to obſerve, that if the Breadth be given in Inches, and the Length in Feet, the Product muſt be divided by 12, and the Quotient will be the Content in Feet; the Remainder, if any, being multiplied by 12, will give the odd Inches.

Example 2. *Suppoſe a Plank or Board,* 20 *Feet long, and* 40 *Inches broad; what is its Area?*

OPERATION.

20
40
12) 800 (66 Feet
72
80
72
8
12
96 Inches

Whence it appears that the Area of a Plank 20 Feet long, and 40 Inches broad, is 66 Feet 96 Inches. — If the Length of the Board had been firſt reduced into Inches, and then multiplied by the Breadth, and the Product divided by 144, the Anſwer would be the very ſame as above.

PROB. 2. *To find the Area of a Rhombus or Rhomboides.*

RULE.

Multiply the ſhorteſt Diſtance between the two longeſt Sides, by one of the ſaid Sides, and the Product will be the the Area required.

Example. *Suppoſe* p t (*Plate* 2. *Fig.* 2.) 130 *Inches, and the Diſtance or Perpendicular* p y 108; *required the Area of the Rhombus* q u p t?

OPERATION.

Multiply —— 130 the Length,
By ——— 108 the Breadth.
1040
1300
14040 Area required in Inches.

Or being divided by 144, we ſhall have 97 Feet 72 Inches, the Area of the Rhombus.

PROB. 3. *To find the Area of a Triangle.*

RULE.

Becauſe every Triangle is the Half of its circumſcribing Parallelogram; therefore in order to find its Area, we muſt multiply the Baſe by half the Perpendicular; or half the Baſe by the Perpendicular, and the Product will be the Area required.

Example. *Let* a b c (*Plate* 2. *Fig.* 3.) *repreſent a Triangular Superficies, whoſe Baſe* a b *is* 260 *Inches, and the Perpendicular* bc 110 *Inches, required its Area.*

OPERATION.

Multiply —— 260 the Baſe,
By ——— 55 half the Perpendicular.
1300
1300
14300 the Area required.

PROB. 4. *To find Area of a Trapezium.*

RULE.

If the Trapezium conſiſts only of four Sides, as *a s b r*, (*Plate* 2. *Fig.* 4.) draw the Line *a b*, and let fall the Perpendiculars *s e*, *c r*, which will divide the Trapezium into two Triangles, whoſe Areas may be found by the preceding Problem; and it is evident from the Figure, that thoſe Triangles are equal to the Trapezium. Or the Area may be found by one Operation thus; multiply the Sum of the two Perpendiculars, *s e* and *c r*, by the Half of *a b*; the Product is the Area of the Trapezium. This is ſo eaſy that it needs no Example.

All other irregular Figures conſiſting of more than four Sides, muſt be divided into Triangles, which will ever be leſs by 2 than the Number of Sides, and then the Areas of all thoſe Traingles will be equal to the Area of the whole Figure.

PROB. 5. *To find the Area of a regular Polygon.*

RULE.

Multiply Half the Sum of the Sides by the Perpendicular, and the Product will be the Area required.

Example. *Suppoſe in a regular Pentagon, each Side, as* d b, (*Pate* 2. *Fig.* 5.) *is* 26 *Inches, and the Perpendicular* c a 16 *Inches; what is the Area of the Pentagon?*

OPERATION.

Multiply —— 65, half the Sum of the Sides,
By —— —— 16, the Perpendicular.
390
65
1040 the Area required.

PROB. 6. *To find the Area of a Circle.*

As it has hitherto proved an inſuperable Difficulty to determine the exact Proportion between a Right-line and a Curve; Mathematicians have been obliged to conſider a Circle as a Polygon of an infinite Number of equal Sides; if therefore half the Sum of theſe be multiplied by half the Diameter or Radius, the Product will be the Area of the Circle, as in the preceding Problem. But before this can be done, the Circumference, or Sum of thoſe infinite Numbers of Sides of which it is ſuppoſed to be compoſed muſt be found. This, when the Diameter is 1, is univerſally allowed to be 3.1415926536, *&c.* Therefore as 1 to 3.14159, *&c.* ſo is the Diameter of any Circle to its Circumference, and *vice verſâ.* And hence we may find the Area of the Circle by the following

RULE.

Multiply the Circumference by one fourth of the Diameter, or half the Radius, and the Product is the Area required.

Example. *What is the Area of a Circle whoſe Diameter is 20 Feet?*

OPERATION.

As 1 : 3.14159 : : 20 : 62.8318 the Circumference. Then
Multiply —— 62.8318 the Circumference
By —————— 5 half the Radius.
314.1590 the Area required.

PROB. 7. *To find the Area of a Sector.*

RULE.

Multiply the Length of the Arch by half the Radius, the Product will be the Content required.

Example. *Suppoſe the Radius* A B (*Plate* 2. *Fig.* 6.) 28 *Inches, and the Arch* B C 30 *Inches, required the Area of the Sector* A B C?

OPERATION.

Multiply —— 30 the Arch,
By ——— 14 half the Radius.
120
30
420 the Area required.

PROB. 8. *To find the Area of the Segment of a Circle.*

RULE.

Draw Lines from the Center of the Circle to the two Extremities of the Arch of the Segment; find the Area of the Sector thus formed, as in the preceding Problem, and alſo the Area of the Triangle formed between the Chord of the Arch, and the Center of the Circle, by Prob. 3. Then ſubtract the Area of the Triangle from the Area of the Sector, and the Remainder will be the Area of the Segment required.

PROB. 9. *To find the Area of an Ellipſis.*

An Ellipſis is a Geometrical Mean between two Circles, whoſe Diameters are reſpectively equal to the Tranſverſe and

Conjugate Diameters of the Ellipſis. Hence to find the Area of any Ellipſis, we have the following General

RULE.

Multiply the Tranſverſe Diameter by the Conjugate, and extract the Square Root out of the Product, which Root will be the Diameter of a Circle, whoſe Area is equal to the Area of the Ellipſis.

Example. *Let it be required to find the Area of an Ellipſis, whoſe Tranſverſe Diameter is* 25, *and its Conjugate* 16 ?

OPERATION.

25
16
150
25
400 | 20 the Diameter of the Circle.
4
·00

Then as 1 : 3.14159, *&c.* : : 20 : 62.8318 the Circumference; and the Area as before found Prob. 6. is 314.159. which is equal to the Area of the Ellipſis required.

Before we conclude this Section, we ſhall explain the Method of finding the Area of Superficies by Croſs Multiplication.

Example. *Let it be required to multiply* 47 *Feet* 8 *Inches, by* 9 *Feet* 4 *Inches.*

OPERATION.

Ft. Inch.
47 . 8
9 . 4
423
6 . 0
15 . 8
2 . 8
444 . 10 . 8

In the foregoing Operation the 47 Feet in the Multiplicand, are multiplied by the 9 Feet in the Multiplier, and the Product is 423 Feet. Then the 9 Feet in the Multiplier are multiplied (croſs-wiſe) by the 8 Inches in the Multiplicand, which gives 72 Inches or 6 Feet. Next the 47 Feet in the Multiplicand are multiplied by the 4 Inches in the Multiplier; which produces 188 Inches, or 15 Feet 8 Inches. Laſtly, the Inches in both the Factors are multiplied together, and produce 32 Parts, *viz.* $\frac{32}{12}$, or 2 Inches and 8 twelfths of an Inch. The Total of theſe ſeveral Products give 444 Feet, 10 Inches, 8 Parts, which is the Product of 47 Feet 8 Inches, by 9 Feet 4 Inches.

Sect. II. MENSURATION *of* SOLIDS.

1. A Solid is that which hath Length, Breadth and Depth, or Thickneſs. And as a Superficies is bounded by Lines, ſo a Solid is bounded by Superficies.

2. A Cube is a Solid conſiſting of ſix Equal Square Sides, in the Form of a Dye.

3. A Parallepiped is a Solid comprehended under ſix Parallelograms, the oppoſite ones whereof are ſimilar, parallel and equal.

4. A Priſm is an oblong Solid, contained under more than four Planes, whoſe Baſes are equal, parallel and like ſituated. It is generated by the Motion of a rectilinear Figure, as ABC (*Plate* 2. *Fig.* 7.) deſcending always parallel to itſelf along the Right-line A E. If the deſcribent be a Triangle, the Solid is ſaid to be a Triangular Priſm; if a Square, the Quadrangular one, *&c.*

It is evident from the Geneſis of the Priſm, that it has two equal and oppoſite Baſes, that it is terminated by as many Parallelograms as the Baſe conſiſts of Sides, and that all the Sections of a Priſm, parallel to its Baſe are equal.

5. A Pyramid is a Solid, ſtanding upon a Square, trangular, or polygonal Baſe, and terminating a Top, or in its Vertex in a Point. — Or it is a Priſm that gradually tapers from its Baſe to its Vertex; where it terminates in a Point.

6. A Cylinder is a Solid, in form of a rolling Stone, being only a round Priſm, having its Baſes or Ends perfect Circles. It is generated by the Revolution of a Parallelogram about one of its Sides, fixed as an Axis.

7. A Cone is a Solid whoſe Baſe is a Circle, from whence it gradually tapers to its Vertex, which terminates in a Point. It is generated by the Revolution of a Right-angled Triangle about one of its Legs, fixed as an Axis.

8. A Sphere or Globe, is a Solid contained under one ſingle curved Surface; being generated by the Rotation of a Semi-circle about its Diameter, fixed as an Axis Whence that Point, which was the Center of the generating Circle, becomes the Center of the Sphere or Globe itſelf, being equally diſtant from every Point in the generated Surface.

9. A Speroid is a Solid, generated by the Revolution of a Semi-Ellipſis about its Axis. If the Rotation be performed about the Tranſverſe or longeſt Axis, it is called a prolate or oblong Spheroid; but when it is generated by the Rotation of a Semi-Ellipſis about its conjugate or ſhorteſt Diameter, it is called an oblate Spheroid.

Having defined theſe Solids, it remains that we ſhew the Methods of finding their Solid Contents.

PROB. 1. *To find the Solid Content of a Cube.*

RULE.

Multiply the Length, Breadth and Depth (which in this Solid are all equal) into one another, and the laſt Product is the Solid Content required.

Note, That 1728 Cubic Inches make one Cubic Foot; for $12 \times 12 \times 12 = 1728$. Therefore when the Dimenſions are taken in Inches, the Solid Content will be alſo Inches, which may be brought into Feet, by dividing by 1728.

Example. *What is the Solid Content of a Cube, whoſe Length, Breadth, and Depth, are each equal to 98 Inches?*

OPERATION.

98 Length.
98 Breadth.
784
882
9604
98 Depth.
76832
86436
941192

Whence the Solid Content of the above Cube is 941192 Cubic Inches, or (by dividing by 1728) 544 Feet, 1160 Inches.

PROB. 2. *To find the Solid Content of a Parallelepiped.*

RULE.

Find the Area of the Parallelogram which conſtitutes its Baſe, and multiply it by the Height, and the Product will be the Solid Content required.

Example. *Required the Solid Content of a Parallelepiped, when the Length of the Parallelogram, which conſtitutes the Baſe is 24 Inches, its Breadth 16 Inches, and the Height of the Parallelepiped 26 Inches.*

OPERATION.

24 Length of the Baſe.
16 Breadth.
144
24
384 Area of the Baſe.
24 Height.
1536
768
9216

Whence the Solid Content is 9216 Inches, or 5 Feet, 576 Inches.

PROB. 3. *To find the Solid Content of a Priſm.*

RULE.

Find the Area of its Baſe, and multiply it by the Height, the Product is the Solid Content required.

Example. *Required the Solid Content of a Square Priſm, the Sides of whoſe Baſe are each* 20 *Inches, and the Height of the Solid* 60 *Inches.*

OPERATION.

20
20
400 Area of the Baſe.
60 Height
24000

Whence its Area is 24000 Inches; or 13 Feet, 1536 Inches.

PROB. 4. *To find the Solid Content of a Pyramid.*

RULE.

Find the Area of the Baſe, multiply that Area by the Height, and divide the Product by three, the Quotient is the Solid Content required; or, which is the ſame thing, find the Area of the Baſe, and multiply it by one third of the Height.

Example. *What is the Solid Content of a Pyramid, whoſe Baſe is a Square, each Side being* 26 *Inches, and the Height of the Solid* 60 *Inches?*

OPERATION.

26
26
156
52
676 Area of the Baſe.
60 Height
3)40560(13520
.....

Or multiply the Area of the Baſe 676 by 20, one third of the Solid's Height, and we ſhall have 13520 Inches, the ſame as before, for the Solid Content of the Pyramid.

PROB. 5. *To find the Solid Content of a Cone.*

RULE.

Find the Area of the Circle which conſtitutes its Baſe, multiply this Area by the Height of the Cone, and divide the Product by 3, the Quotient is the Solid Content required. — Or multiply the Area of the Baſe by one third of the Height, and the Product will be the Content.

Example. *The Solid Content of a Cone, the Diameter of whoſe Baſe is* 60 *Inches, and its Height* 108 *Inches is required.*

OPERATION.

The Area of the circular Baſe (found by Prob. 6. Page 28.) is

2826.44
1.08 the Height.
2261152
2826440
3)305255.52(101751.84.
. . . .

Or by mulitplying 2826.44 by 36, one third of the Height, the Product will be 101751.84, the Content of the Cone, the ſame as before.

PROB. 6. *To find the Solid Content of a Sphere, or Globe.*

RULE.

Find the Area of a Circle, whoſe Diameter is equal to that of the Diameter of the Sphere; multiply that Area by double the Diameter, and divide the Product by 3, the Quotient is the Solid Content. Or, which is the ſame thing, multiply the Area of the Circle by one third of double the Diameter of the Sphere, the Product is the Content.

Example. *Required the Solid Content of a Sphere or Globe, whoſe Diameter is 120 Inches.*

OPERATION.

The Area of a Circle, whoſe Diameter is 120 Inches, found as in the preceeding Problem, is,

11309.76
2 40 double the Diameter.
45239040
2261952
3) 2714342.40 (904780.80
. . . .

Or by multiplying 11309.76, by 80, one third of double the Diameter, the Product will be 904780.80, the Solid Content of the Sphere required.

PROB. 7. *To find the Solid Content of a Spheroid.*

RULE.

Find the Area of a Circle, whoſe Diameter is equal to the Conjugate Diameter of the Spheroid, multiply it by twice the Tranſverſe Diameter, and divide the Product by 3, the Quotient is the Solid Content required. For every Spheroid is equal to two thirds of its circumſcribing Cylinder.

Example *Required the Solid Content of a Spheroid, whoſe Tranſverſe Diameter is 80 Inches, and its Conjugate 60?*

OPERATION.

The Area of a Circle, whoſe Diameter is 60, will be found to be

2827.44
1 60 twice the Tranſ. Diamet.
16964640
282744
3) 452390.40 (150796.8

Whence the Solid Content of the above Spheroid is 150796.8 Inches, or 87.266, &c. Feet.

PROB. 8. *To find the Solid Content of the Fruſtum of a Cone.*

N. B. The Fruſtum of a Cone is a part of that Solid cut off by a Plane, generally parallel to its Baſe.

RULE.

To three times the Rectangle of the two Diameters, add the Square of their Difference; that Sum multiplied by the Height, will give the Solidity.

Example. *Required the Solid Content of the Fruſtum of a Cone, whoſe Diameter at the Top is 20 Inches, at the Bottom 30 Inches, and perpendicular Height 40 Inches?*

OPERATION.

30	Bottom Diameter.
20	Top Diameter.
600	Rectangle.
3	
1800	three Times Rect.
100	Square of Differ.
1900	
40	Height.
76000	Content.

Hence the Solid Content of the above Fruſtum is 76000 Inches, or 48 Feet, 1696 Inches.

PROB. 9. *To find the Content of the Fruſtum of a Square Pyramid.*

RULE.

To the Rectangle of the Sides of the two Baſes, add the Sum of their Squares; that Sum being multiplied into one third of the Fruſtum's Height gives the Solidity.

Example. *Let it be required to find the Solid Content of a Square Pyramid, the Side of whoſe greater Baſe is* 20 *Inches, the Side of the leſſer* 15 *Inches, and the perpendicular Height* 12 *Inches?*

OPERATION.

20 Side greater Baſe.
15 Leſſer Ditto
100
20
300
625 Sum of Squares.
920
4 one third Height.
3680 Content

From the above Operation, the Solid Content is 3680 Inches, or 2 Feet, 234 Inches.

PROB. 10. *To find the Solid Content of irregular Solids, bounded by ſeveral Curve and Plane Superficies.*

In order to ſolve this Problem, the Solid muſt be ſuppoſed to be cut by ſeveral Planes parallel to the Baſe, at ſome determinate Diſtance from each other, as a Foot, or Inch, according as the Solid is leſs or more irregular. Then will each of theſe Sections form two Superficies; and the half Sum of all the Area's of thoſe Superficies, including the Area's of both Baſes, be nearly equal to the Area of the whole Solid. — As we ſhall here only ſhew the Method of meaſuring Timber, we ſhall give no Example, performed according to the above Obſervation, which tho' it approaches much nearer the Truth than moſt others, is not uſed among practical Meaſures. Their Method of finding the Content of a Tree, is as follows;

They girt the Tree with a Chalk-line, or piece of Packthread, near the middle, one quarter of which they take for the true Square; this being multiplied by itſelf, and that Product by the Length, gives the Content of the whole Tree. Ex-

Example. *Admit a Tree* 12 *Feet in Girt, and* 30 *Feet long, what is its Solid Content?*

OPERATION.

$$\begin{array}{rl} 3 & \text{A quarter of the Girt.} \\ \underline{3} & \\ 9 & \\ \underline{30} & \text{Length.} \\ 270 & \text{Content.} \end{array}$$

Hence the Content is 270 Feet.

From the very Nature of this Method, it appears that the Content above is much leſs than the real Quantity of Timber contained in the Piece, the Side being little more than that of the greateſt Square contained in the Piece; and conſequently when the Tree is reduced to a true Square, it will according to this Method, contain nearly the ſame Quantity as before.

Others cauſe the Tree to be hewn ſomewhat in the Form of an irregular Priſm, conſiſting of four flat Sides, and four round; the latter of which are called Wanes; but in meaſuring this Piece, the flat Sides are ſuppoſed to meet and form a Square. They find the Area of the Baſe, which they multiply by the Length, and this laſt Product they ſuppoſe the Content of the Tree. But this Method is not leſs erroneous than the former; for this gives the Content a great deal too much, whereas the former made it too little.

The Government, in order to prevent Impoſitions, Contracts that the Tree ſhall be hew'd in ſuch a Manner, that what is called the Side of the Square ſhall bear a certain Proportion to the Diameter of the Tree; which Proportion may be eaſily determined by the Callipers; for if we apply them to the Wanes, their Extent gives the Diameter of the Square; if to the Flats, the thickneſs, or ſide of the Square. In Order therefore to limit the proper Dimenſions of the Flats and Wanes, it is ordered that the Tree ſhall be hew'd in ſuch a Manner, that two Wanes ſhall be equal to one Square. That is, that the

Square A B, (*Plate* 2. *Fig*. 1.) ſhall be equal to the two Wanes B C and C D. In ſome Contracts the Portion of the Chords, produced beyond the Circumference of the Circle to complete the Square, are called Wanes.

CHAP. IV.

Of the STRENGTH *and* VALUE *of* TIMBER, *&c. uſed by* SHIPWRIGHTS.

IT is ſufficiently Evident from Experience, that Square Pieces of like qualified Timber, equal in Bigneſs, but unequal in Length, being ſupported at each End, and Weights ſuſpended on the Middle, will bear in an inverſe Proportion to their Length. That is, ſuch a Piece of any Length, will bear half the Weight that one of half that Length will bear. And two Pieces equal and alike evenly joined to one another, will not only bear twice, but four times the Weight that one will. In like Manner, any Number of ſuch Pieces, being laid one upon another, will bear Weights in Proportion to the Squares of thoſe Numbers. But if two or more ſuch Pieces be laid Parallel to each other, or Side by Side, the Weights they will then bear, will be in an Arithmetical Proportion to their Number. From hence the Proportion of Strength in different Pieces of Timber, may be eaſily computed. And in Order to this, we ſhall add the Strength of ſome ſorts of Timber, as collected from Experiments.

A Piece of Wood of a Foot long, and an Inch ſquare, ſupported horizontally at both Ends, will bear in the Middle before its Breaks, as follows:

	Pounds
Oak	320
Elm	310
Beech	290
Firr	280

It has been often obſerved to be highly neceſſary to preſerve Timber as whole as poſſible, and that it ought not to be converted, till the Uſe it is deſign'd for be actually known: Which Caution is generally regarded by ſkilful Workmen, it being a great Diſadvantage to reduce Timber to ſmaller Scantlings than it will bear. For if a Piece of long Timber be unadviſedly cut in the Middle, (not to mention the Weakneſs of a Ship compoſed of ſhort and narrow Pieces of Plank and Timber) the Opportunity is loſt of converting it to the moſt proper Service, as to what it would make Length-ways, which is not only as 2 to 1, but as 4 to 1; each Half before the cutting being alike ſerviceable one to the other, and having not only the ſingle, but joint Properties of each other. However the Pieces will not be as 4 to 1 leſs in Value than they were, becauſe they ſtill contain their Bigneſs, being alſo applicable to Breadth and Thickneſs. Therefore if you Imagine a Piece of Timber whoſe Sides are ſquare, and of a certain Length, and another in all reſpects like the former, but only twice its Length; the larger Piece will contain 8 times the Quantity of the ſmaller, and conſequently will be 8 times the Value, and every way throughout of double Scantlings; by which means being adapted to various Uſes, and preventing the Charge of unneceſſary Piecing and Scarphing, it will be as 4 to 1; and ſo increaſe the Value as 32 to 4, that is 8 times. But if it be conſidered what was ſaid before concerning its Strength, it will appear that this large Piece will be 4 times ſtronger than the other. Tho' being 8 times the Quantity, it may alſo be naturally expected to be 8 times the Strength; but being only 4 times as ſtrong, conſequently 'tis but half the Value expected. So that the real Value of theſe two Pieces of Timber is but as 1 to 16.

I ſhall therefore from theſe Principles lay down a Rule, which probably may adjuſt, and give at leaſt a Proportion of the Value of large Timber compared with ſmall. Tho' the Scarcity of the Commodity, and extreme want of it, with ſeveral other intervening Circumſtances may alter the Caſe very much; however theſe Conſiderations do not alter the intrinſic Value of the Materials, compared with each other, provided there be a general Uſe of all ſorts of ſound Timber proportionably to the

Bulk it bears. And where the Caſe is not ſo, double Care ought to be taken to provide only ſuch as is uſeful.

Wherefore finding by Experience the uſual Prices of Timber at ſome Places to be near the Rules hereafter mentioned, I ſhall make one uſeful to the other, in order to reduce both to a general Scale, which being fully known, Perſons will not hereafter be ſo liable to be impos'd on by thoſe, who, perhaps to rid themſelves of a bad Bargain, will endeavour to over-reach others; but on the contrary, as theſe Commodities riſe and fall, the intrinſic Value or Proportion may be ſtill kept, and the Prices raiſed or abated ſo much *per Cent.*

If what has been already, or hereafter may be ſaid, comes not up to a Demonſtration, yet the thing occuring with ſo many repeated Obſervations, will be near enough for Practice, and the moſt curious Demonſtration can make but an inſenſible Difference therein. However I ſhall only offer it as an Eſtimate, and proceed; the Deſign being rather to give a Proportion of the Value, than an Account of the current Price, which always will be various.

Taking it then for granted that like oblong Pieces of Timber (being as 1 to 8 in Quantity, or double to each other in Length, Breadth and Thickneſs) are in Value as 1 to 16; it will be found by comparing the Properties of divers ſuch Pieces together, that the Value of like ſimiliar Pieces are in Proportion to the Surſolidity of the Cube Root of their Quantities; or as the Quantity multiplied into their Cube Roots; and that an equal Quantity (either *per* Foot or *per* Load) of ſuch ſimiliar Forms, are valuable in direct Proportion to the Extent of their Homologus Dimenſion, or in Proportion to the Cube Roots of their Quantity.

Again, If you Imagine a Piece of Timber, in Form of a Paralleliped, and another double to it either in Length or Breadth, by either of the ways the new Piece will be augmented in Value as well as Quantity: Let either of the latter Pieces be called a double Piece, and either of them be again doubled, the long Piece in Breadth, or the ſhort one in Thickneſs, they will alſo be alike augmented in Quantity and Value: Let either of them be called a Quadruple Piece, and ſuppoſe it again doubled, the ſhort one in Length, or the long one in Thickneſs, making either way an Octuple Piece, an Oblong ſimiliar to the firſt or ſingle Piece, as was before mention'd, and of 16 times the Value: Let thoſe 4 Pieces, *viz.* the Single, Double, Quadruple, Octuple, be diſtinguiſhed according to their reſpective Orders, by A, B, C, and D, then the Value and Quantity thereof is as A : B : : B : C, and B : C : : C : D. Alſo A : B : : C : D, or as 1 : B : : C : 16, conſequently B = Cube Root of 16.

Thus —— $\left\{\begin{array}{l}1 : 2 : : 4 : 8 : \textit{per}\ \text{Quantity.}\\ A : B : : C : D.\\ 1 : 2{,}52 : : 6{,}32 : 16\ \textit{feré, per}\ \text{Value.}\end{array}\right.$

But 16 is a Surſolid, compounded of 2. the Cube Root of 8, as 6,32 is a Surſolid compounded of 1,58, and 2,52 of 1,26 the like Root of 2: which Roots are alſo proportionable,

$\left\{\begin{array}{l}1 : 1{,}26 : : 1{,}58 : 2.\\ A : B : : C : D.\end{array}\right.$

And by tracing this Method throughout, it will be found, that not only ſimilar Pieces, but alſo all other regular oblong Forms of like qualified Timber, are in Value proportionable to the Surſolidity of the Cube Roots of their Quantities; or that a Load of one ſhall be proportionable to the other, as the Cube Roots of the Quantities; provided, all Timber of what ſhape ſoever, be alike uſeful according to the Bulk it bears, and alike eaſy to be procured. And this Rule I doubt not will hold without Exception in rough Timber, making a difference only in compaſs Timber, Knees, *&c.* which for their Scarcity and Uſefulneſs are of much more Value than Strait.

But in converted Timber ſome ſmall Difference will happen, eſpecially when the Contents differ much, through the Charge of many Converſions, the Waſte which carries more or leſs in cutting, either of Square Timber or Plank, and the Value of the Piece out of which the ſame is cut, *&c.* As in Oak Board, where the Timber is required to be quarter'd; and in Trenels, where great part of the Piece is waſted for the ſake of But, *&c.* All which ought to be duly conſidered before any Eſtimate can

be

be ſet thereon. To which may be added the Hazard the Vender runs, and the Advantage the Buyer hath in ſeeing the Inſide, and diſcovering the Defects, which before lay hid from the moſt curious Search.

Upon the whole then, I ſhall offer this as a general Rule, that like ſimilar and uſeful Pieces of Timber are valuable in Proportion to the Surſolidity made of the Cube Roots of their Quantities; or an equal Quantity of each is reciprocally porportionable to the Content of their Homologous; Dimenſions or which is all one, to the Cube Roots of the Quantity.

Compare ſtrait Oak with ſtrait, Compaſs with Compaſs, Knees with Knees, Elm with Elm, converted Timber, as Beams, Foot-hooks, Thick-ſtuffs, Planks, *&c.* to like Pieces and Forms. And hence are reduced the following Tables.

Elm in ſome Places is, according to its Quantity near as valuable as ſtrait Oak, or within 5 *per Cent.* but Beach for its Uſeleſsneſs and Plenty is not ſo valuable by above 12 *per Cent.*

It is farther obſervable, that the Method of buying a Quantity of Timber, is to add the Contents together of the ſeveral Pieces; the Sum thereof is called the *Meeting* of that Timber, and according thereto the Value of the whole Quantity is Sold. Which Method, tho' perhaps near enough for Practice, is not really true. For whoever adds the reſpective Value of each Piece by it ſelf, will find the Sum total conſiderably to exceed what it would by adjuſting the Price by the aforeſaid Meetings.

Neither do I perceive any General Rule to be given in ſo various a Matter, when every different Content alters the Caſe, except to add the Value of every individual Piece; which being ſo intricate and troubleſome, I ſhall only obſerve that this Difference ariſes from the Diſproportion between the Contents of the large and ſmall Timber; and the wider that is, the greater will be the Alteration; the Value of the large being much diminiſh'd, by being compared with the ſmall.

From which it may be obſerved, that it is the Vender's Advantage to ſell his Timber in as many Parcels as he can; and alſo whenſoever an Eſtimate is to be put upon one ſingle Piece, or upon a Quantity whoſe Contents are near equal, an Abatement ought to be made of about 5 *per Cent.* in order to make the ſame agree with the following Tables, which are deſigned for a Quantity, according to the common Cuſtom of Meeting.

An Eſtimate of the Value of Oak Timber, *as 'tis ſuppoſed to be worth in divers Places, ſerved to the Place of Buſineſs free of all Charge to the Manager.*

Strait				Compaſs				Rate *per* Load.		
Meeting one with another.	No Piece under			Meeting one with another.	No Piece under					
	Content	Length	Top end		Content	Length	Top end			
Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet	l.	s.	d.
240	—	—	—	192	—	—	—	3	17	11
235	—	—	—	188	—	—	—	3	17	4
230	—	—	—	184	—	—	—	3	16	9
235	—	—	—	180	—	—	—	3	16	2
220	—	—	—	176	—	—	—	3	15	7
215	56	26	13	172	37	17	12	3	15	0
210	—	—	—	168	—	—	—	3	14	4
205	—	—	—	164	—	—	—	3	13	8
200	—	—	—	160	—	—	—	3	13	0
195	—	—	—	156	—	—	—	3	12	4
190	—	—	—	152	—	—	—	3	11	8
185	—	—	—	148	—	—	—	3	11	0
180	48	24	12	144	32	16	11	3	10	4
175	—	—	—	140	—	—	—	3	9	8
170	—	—	—	136	—	—	—	5	9	0
165	—	—	—	132	—	—	—	3	8	4
160	—	—	—	128	—	—	—	3	7	8
155	—	—	—	124	—	—	—	3	7	0
150	—	—	—	120	—	—	—	3	6	3
145	40	22	11	116	27	15	10	3	5	6
140	—	—	—	112	—	—	—	3	4	9
135	—	—	—	108	—	—	—	3	4	0
130	—	—	—	104	—	—	—	3	3	3
125	—	—	—	100	—	—	—	3	2	6
120	—	—	—	96	—	—	—	3	1	8
115	—	—	—	92	—	—	—	3	0	10
110	32	20	10	88	22	14	9	2	19	11
105	—	—	—	84	—	—	—	2	19	0
100	—	—	—	80	—	—	—	2	18	1
95	—	—	—	76	—	—	—	2	17	1
90	—	—	—	72	—	—	—	2	16	1
85	—	—	—	68	—	—	—	2	15	0
80	—	—	—	64	—	—	—	2	13	10
75	24	18	9	60	17	13	8	2	12	7
70	—	—	—	56	—	—	—	2	11	4
65	—	—	—	52	—	—	—	2	10	1
60	—	—	—	48	—	—	—	2	8	11
55	—	—	—	44	—	—	—	2	7	6
50	—	—	—	40	—	—	—	2	6	0
45	—	—	—	36	—	—	—	2	4	4
40	16	16	8	32	12	12	7	2	2	8
35	—	—	—	28	—	—	—	2	0	11
30	—	—	—	24	—	—	—	1	19	0
25	—	—	—	20	—	—	—	1	16	7
20	—	—	—	16	—	—	—	1	13	9
15	—	—	—	12	—	—	—	1	10	8

An Eſtimate of the Value of Knees, none being under the following Content; $\frac{1}{3}$ being Raking, and $\frac{2}{3}$ Square.

Contents	Meeting.	Rate *per* Load.		
Feet	Feet	l.	s.	d.
8	36	5	10	0
7		5	6	0
6	27	5	0	0
5		4	14	0
4		4	7	0
3	14	4	0	0

An Eſtimate of the Value of Beams converted, &c.

Length	Square	Rate *per* Load.			Value of each.		
Feet	Inches	l.	s.	d.	l.	s.	d.
44	18	9	10	0	18	10	0
43		9	7	6	17	16	6
42		9	5	0	17	5	0
41	17	8	18	0	14	12	0
40		8	17	0	14	1	0
39		8	15	6	13	10	0
38	16	8	8	0	11	5	0
37		8	6	6	10	16	6
36		8	5	0	10	9	0
35	15	7	16	0	8	10	0
34		7	14	0	8	3	0
33		7	12	0	7	16	0
32	14	7	5	0	6	7	0
31		7	2	6	5	18	6
30		7	0	0	5	12	0
29	13	6	13	0	4	10	0
28		6	11	6	4	6	0
27		6	10	0	4	2	6

An Eſtimate of the Value of Oak Plank.

Thick-neſs.	Meeting in Length.	None under		Rate *per* Load.		
		Length	Breadth top end			
Inches.	Feet	Feet	Inches	l.	s.	d.
4	32	—	—	6	11	0
	31	—	—	6	9	0
	30	23	12	6	7	6
	29	—	—	6	6	0
	28	—	—	6	5	0
3	27	—	—	5	11	0
	26	20	11	5	9	6
	25	—	—	5	8	0
2	24	—	—	4	13	0
	23	17	10	4	12	0
	22	—	—	4	11	0
1½	21	—	—	4	2	0
	20	14	9	4	0	6
	19	—	—	3	19	0

An Eſtimate of the Value of Oak Trenels.

Length	Diame-ter	Charge of making		Value of the Neceſſary Wood			Rate *per* Thouſand		
Inches	Inches	s.	d.	l.	s.	d.	l.	s.	d.
36	2—0	30	0	10	10	0	12	0	0
30	1—8	21	9	6	3	3	7	5	0
24	1—6	15	0	3	10	0	4	5	0
18	1—4	9	9	1	12	9	2	2	6
12	1—2	6	0	0	14	0	1	0	0

The irregular Form of Ships renders the procuring Timber for Building them both difficult and expenſive. For if Ships were regularly formed by ſome Geometrical Curve or Figure, Timber and all other Utenſils might be as well provided for them, as for Building any other Fabric; Timber might be converted to its various Uſes in the Woods, and conſequently Carriage paid for only what is really Uſeful; and as both the Safety and Commerce of this Nation greatly depend on the Strength and Number of our Shipping, the Care of our Foreſts well deſerves our ſerious Attention, as it muſt be very diſadvantageous, to be obliged to have recourſe to our Neighbours, and purchaſe at a very conſiderable, and continually renewed Expence, what might, by an eaſy Œconomy, be ſufficiently ſupplied at home.

It would therefore, in order to the preſerving our growing Timber Trees, be a very uſeful Law, that all who cut down any Number of Oaks, ſhould alſo leave a certain Number in good Condition for After-cutting; and that no Timber ſhould be cut down but at a proper Age, in regard to the Nature of the Soil; ſince it is certain, that Trees grow to their Perfection at very different Periods of Time, in Proportion to the Depth of the Soil, and that as it is not for the Intereſt of the State to ſuffer Trees to be cut, till at their Perfection for Size and Soundneſs, ſo after they are arrived at that Perfection, it is equally certain that they gradually decay.

The Quality of the Soil may be neceſſary to be obſerved for this Purpoſe; but the Quantity or Depth of it, is the great Subject of Enquiry; and a great Number of Obſervations have proved, that the proper Seaſon for cutting Oaks, in a Soil of two Feet and a half deep, is at Fifty Years old; thoſe which ſtand in a Soil of three Feet and a half deep, ſhould not be cut before Seventy Years; and thoſe which ſtand in a Soil of four Feet and an half deep, or more, will increaſe in Goodneſs and in Soil, till they are an Hundred Years old. And Obſervations have proved, that, after theſe ſeveral Periods, the Trees begin to decay.

This ſeems the beſt Rule to eſtabliſh in regard to common Soil; but thoſe which grow in a lighter or more ſandy

Soil, may have their Periods changed from thoſe above to Forty, Sixty, and Eighty Years, at the greateſt Depth; it is always beſt to fell the Wood intended for Public Service, whether then wanted or not; ſince it is much better to keep it in Magazines, than to ſuffer it to ſtand, and daily decay.

Heaths, and other uncultivated Places, generally afford ſome ſtraggling Trees of the Oak. Theſe ſeldom grow tall or regular, ſince not having been defended from the Injuries of Cattle, they are uſually browſed on and ſtunted, while Young, and ſo become crooked or ſhort-trunked, or Pollard Trees. Theſe are, however, of great Value to Shipwrights, being naturally bent, and formed for many Uſes in Marine Architecture.

The little Care uſually taken of theſe Trees, tho' in this reſpect, of the greateſt Value, ſeems to threaten a general Loſs of them; but, as Trees thus crooked and bent, are of great Value in Ship-building, it is a uſeful Attempt to endeavour to diſcover a regular Method of producing ſuch; and this is eaſily practicable, by following the ſame Method by which theſe wild ones became ſo. They wholly owe their Figure to the Cattle's biting off their Tops while Young, and afterwards biting off the Tops of the Shoots from the firſt Wound. In this Manner, if a Number of Young Trees, ſet apart for the Experiment, have their Tops cut off at two, four, ſix, eight, ten and twelve Feet from the Ground; and four Years afterwards, the Shoots of theſe ſtunted Tops again cut in the ſame Manner, the Trees will be found afterwards to grow up in all the irregular crooked Figures that can be conceived; and by this Means, a ſupply of naturally crooked Timber may be raiſed for the Occaſions of Ship-building, with eaſe and certainty.

The Defects of Timber are various; but they are, in general, owing to the Nature of the Soil. In looſe and broken Ground the Timber is uſually ſhaken, which is a common Defect, and very pernicious. A ſtrong Clay commonly produces good Timber.

Timber from 4 Inches to 1 Inch and half Inch, is called Plank, and uſed for covering the Timbers, and being well calked, keeps the Cavity dry. This is generally converted to its intended Thickneſs in the Woods.

CHAP. V.

Of delineating the FORMS *or* MODELS *of the Timbers of* SHIPS.

WHEN a Ship or Veſſel is propoſed to be Built, the firſt thing mentioned is her Dimenſions, as Length, Breadth, Depth, *&c.* Theſe being determined, the Timbers which form the Sides of the Ship muſt be conſidered. A Frame of Timbers is compoſed of one Floor Timber, two or three Futtocks, and on each Side a Top Timber. Theſe being united and properly ſecured, form a circular Incloſure, of which that circumſcribing the greateſt Area is termed the Midſhip Frame. The Curve of this Frame at the lower Part is inverted, whence the Floor Timber, in the Middle, will be ſomewhat hollow, and, conſequently, the Ends form a very Obtuſe Angle; but his Angle decreaſes in ſuch Proportion to the Diſtance of the frame from the Midſhip, that the foremoſt and aftermoſt may become very ſharp, and form a very Acute Angle.

Shipwrights are generally agreed with regard to the Length of the Midſhip Floor Timber, making it generally half the Length of the Main Beam; but with regard to the Riſing of it, they differ extremely; ſome chuſing a ſharp, and others a flat Floor. Each has its Advantages and Diſadvantages; for the more Riſing a Ship has, ſhe will ſail the better when cloſe upon a Wind; but then ſhe will draw the more Water. On the contrary, the flatter a Ship is, the leſs Water ſhe will draw, but then ſhe will not ſail ſo well when cloſe upon a Wind.

Nor are the Shipwrights better agreed in determining the Station of the Midſhip Frame, ſome placing it before, others at the Middle of the Ship; others again have two Floor Timbers of equal Length and Riſing, one of which they place exactly in the Middle, or the Breadth of the Timber nearer the Head, and the other a proper Diſtance before it.

Thoſe who place it before the Middle of the Ship alledge that a Ship which is full Forward, after ſhe has once divided a Column of Water, ſhe will meet with no farther Reſiſtance, and the Fluid will eaſily unite abaft, and by that Means increaſe the Ship's velocity, and have more Power on the Rudder, the farther it is from the Center of Gravity. They alſo add that a Ship built in this Manner comes the neareſt to the Forms of Fiſhes, which ſeems the moſt Advantageous for dividing Fluids.

Thoſe, on the other Hand, who would have it placed in Midſhips, are of Opinion, that the Water-lines Forward, are by that Means the eaſier, and conſequently better adapted for dividing Fluids; and that, betwixt it and the Rudder, that is ſpace ſufficient for forming fair Water-lines; ſo that the Fluid will eaſily unite at the Rudder. The Building alſo will be greatly facilitated, and the fore and after Ports of the Ship more eaſily balanced.

The Riſing of the Midſhip Floor Timber being determined; the next thing is to fix the Height of the Riſing-line of the Floor, both abaft on the Stern-Poſt, and forwards upon the Stem.

As all Ships are narrower both Abaft and Forward than in Midſhips, the other Floor Timbers will conſequently be ſhorter, and have a greater Riſing, which will continually increaſe till it terminates on the Poſt and Stem. Builders Uſe different Methods in fixing the Height of this Line. Some are of Opinion, that by narrowing the Floor abaft, which will cauſe the Riſing-line on the Poſt to be high, the Ship will not only ſteer the better, but the Water being opened by the Midſhip Frame, will cauſe a greater Preſſure on the after Port of the Ship, and thereby increaſe her Velocity. But this Opinion does not ſeem to be well founded. Indeed if the Steerage were the only thing to be conſidered, it muſt be granted, that the higher the Riſing-line is carried abaft, and the narrower a Ship is, the Water will have the freer Paſſage to the Rudder, and have the more Power upon it. But it muſt be remembered that by this Means we take away the Buttock, which is the only thing we have to ſupport all the Weight of the after Part of the Ship; neither ſhall we be able to give a proper Balance between the fore and after Parts; and when theſe are not duly balanced, it will cauſe the Ship to pitch very much, and be in danger of being pooped by the Sea, when it runs high. And therefore to prevent theſe Inconveniences, it will be proper to give all Ships, eſpecially thoſe which are large, a full Buttock.

The Dimenſions being agreed upon, a Draught is prepared proportionable to theſe Meaſures; but as a Plane has but two Dimenſions, *viz.* Length and Breadth, and a Solid three, they cannot all be repreſented on the ſame Plane by one ſingle Projection. Shipwrights generally make Uſe of three Planes to repreſent the Dimenſions of one Ship, which they call the Sheer Plane, the Floor Plane, and the Body.

The Sheer Plane is the ſame which Architects call the Elevation, being the Section of a Ship, ſuppoſed to be cut by a Plane paſſing through the Middle Line of the Keel, Stem, and Stern-Poſt. This Plane is repreſented on *Plate* 1. *Fig.* A.

On this Plane the Heights of the Breadth-lines are deſcribed in order to determine the Heights, at which the Half Breadth-lines are to be ſet off. Theſe Lines, becauſe the extreme Breadth of each Timber riſes gradually, from the Midſhips fore and aft, will be Curves.

The Floor Plane, is that which other Artiſts calls the Horizontal, or Plan of a Building, being that on which the whole Structure is erected. This Plane is repreſented, *Plate* 1. *Fig.* H.

On this Plane are deſcribed the Half Breadth Lines, which are Curves limiting the Half Breadths of the Planes of the Timbers, at the Heights expreſſed by the correſponding Height of Breadth on the Sheer Plane. Theſe Curves are formed by ſuppoſing the Ship to be cut lengthways by a Plane perpendicular to the Sheer Plane through a Curve Height of Breadth Line.

The Body is the ſame which others call a Profile: It is a Section ſuppoſed to be cut by a Plane, perpendicular to both the Sheer and Floor Planes, through the broadeſt Part of the Ship. This Section is repreſented, *Plate* 1. *Fig.* D.

The Draught or Model is uſually deſcribed upon large Paper, and the Scale uſed in delineating it, is generally as 1 to 48, that is, the Diſtance between each large Diviſion is $\frac{1}{4}$ of an

Inch; conſequently every quarter of an Inch on the Paper is a Foot, or twelve Inches on the Platform, fitted for that Purpoſe.

The Platform uſed for drawing theſe Deſigns, is called a Mould-loft; and in large Yards, where great Ships are built, it is a ſpacious Floor with large and convenient Lights, diſpoſed as much as poſſible for the direct Reception of the Light. The Floor is laid very ſmooth and even; and to render the Marks, which among Shipwrights are generally of Chalk, the more conſpicuous, the Floor is waſhed over with black Size.

The Platform being prepared, the next thing is to get all neceſſary Conveniencies for the purpoſe; as dry and ſeaſoned Deal fit to make the Moulds, plaining it very ſmooth, and the Inſtruments, which they term Sweeps, to mark out the Moulds which compoſe the Body. If the Place be large enough, it will not be at all improper to lay down ſome of the tranſverſe Lines, or the Body of the Ship lengthways; to lay down the Riſing-lines, and Half Breadth-lines, or indeed all the Lines which form the Ship's Body; ſince it will be moulded much truer form Lines drawn at large, than from a Draught, which is but as 1 to 48, compared to the Ship's Body.

When ſuch Lines are laid down, and the Perpendicular-lines marked on them, as may be ſeen, *Plate* 1. *Fig*. A. where the Lines marked *a*, *b*, are the Perpendiculars drawn at the ſtanding of every Timber, from Stem to Stern, and is called, as we before obſerved, the Sheer Plane: Then with long Staves, fitted for that purpoſe, as are repreſented *Fig*. B; mark off the Diſtance from the Middle Line C D, (*Fig*. H.) or elſe from the upper Edge of the Keel *e*, *f*, (*Fig*. A.) to the Riſing of the Floor Line, and of the Breadth, as may be ſeen in the Figure. When the Staves are all marked, as the Riſing of the Floor, the Breadth and Height of the Top Timber Sir-mark from the Breadth; likewiſe the narrowing of the Breadth and Top Timber Breadth, you may rub out thoſe Lines, and proceed to lay down the Timbers as in *Fig*. D.

In this Figure every Timber from Stem to Stern, in a Ship of 1000 Tuns, is laid down from a $\frac{1}{4}$ Scale, as above obſerſerved. If the Mould-loft be large enough, you may draw the Timbers fore and aft together, as may be ſeen in the Figure; but if not, it may be done ſeparately, beginning from the middle Flat, both fore and aft; obſerving that the aft Side of every Timber be marked down forward, and the foremoſt Side aft. So that in moulding the Timbers, the Floor Timbers muſt be leveled under (as the Shipwrights call it) the firſt Foot-hook ſtanding, the ſecond Foot-hook under, the third ſtanding, and ſo on, contrary to the laſt or Top Timber.

In laying down the Body you muſt draw a ſtrait Line *a*, *b*, (*Fig.* D.) imagining it to be an Horizontal-line, as the lower part of any Ship, which it repreſents, ought directly to be; then at C, erect the Line C D, exactly perpendicular to the Horizontal-line *a*, *b*. The Side C D repreſents the middle Line of the Ship, biſecting the Body into two equal Parts; from which you ſet off the Ship's half Breadth each way, in order to mark out the Midſhip Timber. And having drawn two Lines parallel to the middle Line, with the exact Diſtance of the Ship's extream half Breadth, as the Lines *a*, *f*. *g*, *b*, you ſet off the Height of Breadth *h*, *i*, and upper Height of Breadth (if you approve of any) which will be *K*, *L*; then the Height of the Sir-mark of the Top-Timber *m*, *n*, alſo the Riſing-line *o*, *p*, and the narrowing of the Floor Line *p*, *r*. Then having your Sweep long enough to put one Point at *r*, with the other ſtrike the Circle *p*, *i*, *p*, *h*, which will deſcribe a Midſhip Bend more agreeable, and leſs perplexing, than if you was to Chalk out 100 Segments of Circles. 'Tis ſaid indeed, that the Catanera Line will deſcribe a Shape of the greateſt Gravity; but I ſhall leave ſuch nice Demonſtrations at preſent, and proceed to ſhew an intelligible Method to ſuit and forward young Beginners.

From *h* to *L*, and from *i* to *K*, is ſtrait, approved on to make a Ship ſtiff, or bear Sail, which is undeniably a good Faculty for that purpoſe. From *K*, and *L*, you deſcribe a Segment upwards, as *K*, *S*, and *L*, *S*, which Segment is made general from Stem to Stern. From the upper Height of Breadth, you revert ſuch a Curve from *S*, to the Half Breadth, approved on at the Top-Timber Head, which is termed the

Back-ſweep *S*, *m*, and *S*, *n*, and ſo is your Midſhip Timber market out; only below, from the Riſing of the Floor to the Keel, you ſtrike a ſtrait Line, or commence a ſmall Hollow from the Midſhips forward and aft, as the Lines *x*, *p*. *x*, *p*.

But before I proceed to lay down every Timber, I ſhall mark out the Midſhip Timber ſeparately, and ſet off the Scantling or Meaſure of the Timber, in order to make out a Bend or Suit of Moulds, of which you ought to have two Suits, one for the fore, and the other for the after Body.

Figure E, ſhews ſuch a Work. From *a* to *b*, is the Floor Timber Mould *c o*, *d o*, being a Level-line to level the firſt Floor, or Seat of the Ship; and all below that is work'd down, either by a ſtrait Line, or a hollow Mould. From *i a*, to *i c*, is the ſecond Foot-hook Mould, which joins to the Floor. And for a more clear Explication of this Work, I have made another Tire of Timbers, as in Figure F, where from ^2a, to ^2b, is the lower Foot-hook, the Middle of which goes to the Head and Heel of the Floor Timber, and ſecond Foot-hook; from ^2b, to *x*, is the third Foot-hook, which overlaunches the 2*d* and 4*th* Foot-hook, as the lower Foot-hook doth the Floor Timber and ſecond Foot-hook; from *i c*, to *D i*, is the Top Timber in *Fig*. E. And it may be farther obſerved, that every Timber interchangeably ſcarphs and overlaunches each other, as was firſt deſcribed in the lower Foot-hook.

When two Sets of ſuch Moulds are formed very exact, and fitted in every reſpect, a Preparation is made to lay down every Timber, which may be done divers ways: As, by faſtening (term'd Tacking) all the Mould together as high as the Breadth, and lifting them according to the Riſing-lines *R's*, and narrowing them by the narrowing of the Breadths *N*, ſo that all the Body or Ribs of the Ship may be marked out. This Faſhion is called Whole Moulding. But I ſhall lay down a more exact Way, and yet as eaſy. For when all the Riſing-lines are laid down, and narrowings or tapering Parallels of the lower part *L*'s, then the Lines *r M*, will afford general Centers at every one of thoſe Interſections, either to the fore or after Body. Notwithſtanding it may be obſerved, that the proper Floor Line aft increaſes in Breadth, inſtead of narrowing, according to the general Opinion, which is cauſed by a ſquare or broad Stern; the

Diſproportion or Tapering being far larger between the Riſing-line and the Breadth-line, than between the narrowing of the Breadth-line and the Middle-line of the Ship.

The Centers of the Floor being pitch'd upon, the next thing is the riſing and narrowing of the Breadth, which is done by firſt ſetting off every Height of Breadth parallel to the Midſhip Height of Breadth-line, and alſo of the narrowing of the Breadth-lines *B*'s. By which Interſections, cauſed by the Lines *B*'s and *C*'s, general Centers may be found to mark out every Timber fore and aft below the Breadth, provided the Ship's Body was to be a perfect Conoid. But ſuch a Shape being not approved of, 'tis thought proper to carry down every Timber to the Keel, by reverting the Curve; ſo that having prepared another Riſing-line, called a Riſing ſtrait Line, ſomewhat below the other Riſing-line, it marks out a Tangent-line at every Timber, to revert the Curve. For as the Lines *R*'s are Parallels or Horizontals, ſo the other are upon a certain Angle between.

Then making a Mould at the Timber 30, or thereabouts, and reverting the Curve at that Timber, a Mould may be made general, by which to mark out every Timber, by always guiding the ſtrait Part of the Mould in the Lines *L*'s, which may be made general for delineating this Ship, or any Veſſel's Body fore and aft.

The upper Height of Breadth Sir-marks are obtained from the lower, ſince they are directly perpendicular one way, ſo that there is nothing elſe to do but to ſet up the Difference between the upper and lower Breadth-lines, on thoſe Perpendicular-lines *B*'s, which mark out the Line *O*, *X*, in which are the Centers to deſcribe the lower Sweeps of the Top Timber *S*.

The upper part of the Ship will be found to be more perplex'd in the Compoſition than the lower, which is cauſed by the large Accommodations in the Aft-part, and the conveniency of making the Head Rails ſpread, for beautifying the Ship forward, and clearing the Anchor from the Bow. However the Height of every Sir-mark, parallel to the Sheer of the Ship at the lower part of the Weſt Rail, is ſet up parallel to the Parallels of the Breadth, as the Lines 2*s*, and alſo every

Narrowing at that Place, by which the Lines *n w*, and *m w*, are found, which produces the Sir-marks, or half Breadth of every Top-timber. You may obſerve, that from thoſe Sir-marks in the foremoſt Timbers, which are marked alphabetically, the Forward Timbers are drawn directly perpendicular upwards; but in the After Body, which is number'd 1, 2, 3, the Timbers are drawn upwards from the Sir-marks, ſomething declining from a Perpendicular, according to the Angle made by the Midſhip Timber. But the principal Piece of Management is to reconcile the Timbers between the Breadth and the Top-timber Sir-mark, termed working the Hollow out aft, and working one in forward. And ſince this is to make the Work go truly circular, according to the direct Shape of the Ship, and eſpecially at every perpendicular Height of each reſpective Strake of Plank between the main Breadth and Top-timber Sir-mark, it would be very proper to deſcribe one or two tranſverſe Lines between thoſe Parts, and ſo tranſcribe the Breadth at ſuch intermediate Lines, on the Lines *y z*, *y S*, and *z S*, which will adjuſt the Top-timbers, and renders the Work true and neat. But you muſt obſerve, firſt to pitch upon the Faſhion of your foremoſt and aftermoſt Timber, which upwards chiefly depends on Fancy; for ſome chuſe to work more hollow, and ſome leſs, between the Breadth and the Top-timber Sir-mark.

But there are ſo many things proper to be known, in order to work a Ship's Body, as firſt to draw the Draught, then to tranſcribe that Draught to Foot Meaſure (which is called laying down a Body in the Mould-loft) and afterwards to croſs the Moulds, and take every Dimenſion proper to Mould the Timber, both with Frugality in the Converſion of the Timber, and Accuracy in the Performance, that I can't but wonder it has not been more publickly looked into. Let any one but take a ſerious View of the Shape of a Ship under Water, as may plainly be ſeen in this Figure, how every Timber turns it ſelf in a different Form, and what a Complication of Matter is requiſite in compoſing ſuch a Machine, and he muſt needs admire how ſuch a confuſed Piece of Work could be brought to Perfection.

Obſerve that the Figure E and F, ſhew the Scantling or Bigneſs of the Midſhip Timbers in and out, and that every Timber fore and aft ought to be equal to them, according to the reſpective Length and Breadth of every Timber, which may ſuffice for the Bigneſs of the Parts.

What is meant by the term Croſſing of Moulds, is no otherwiſe to be underſtood, than from the different Shape of the Ship's Body, ſince the Midſhip Timber Moulds will not directly fit in any Place but in the Midſhips, or a few Timbers that differ nothing from the very Midſhip Timber. For as the Radius differs, they croſs one another, and will not agree to the Boundings that are requiſite in ſhaping every Timber.

However, theſe Midſhip Moulds (as may be ſeen in the Figures F and E,) are made Uſe of as far as the Breadth of the Mould will ſuffer to be marked, ſo as conveniently to be marked off again by ſuch a Mould on the Timbers which are provided for the Frame. And indeed I cannot ſee much good Huſbandry in ſaving a Mould, and loſing a Timber, ſince the different Value between them is ſo very much; and having obſerved once a Mould made intire, from the Keel to the Breadth, with whole Deal for every Timber, I am of Opinion that there may be as much ill Management in being overſaving in the Expence of making a few Slit-deal Moulds extraordinary from the common Cuſtom, as the other Faſhion was ſuperfluous, ſince Ships Timbers are ſo very different in the Compoſition.

In croſſing the Moulds, eſpecial Care is to be taken to mark them at the Sir-mark Lines, which are ſo marked; alſo to mark the Heads and Heels of every Timber, in order to ſhew an exact Length. The Sir-marks are placed near the Heads and Heels of every Timber, and at thoſe Places there are Bevelings taken off, and put upon a Board fitted for that Purpoſe, to ſhew the Workman how to fit his Timber exactly to the Work. For it may be obſerved in the Figure, that ſince every Timber alters the Shape one within another, they are not exactly ſquare, but turn themſelves into different Rhombus's, according to the different tapering of the Ship's Body forward and aft.

Figure G, ſhews the Natute of diminiſhing or tapering the Timbers upwards, deſcribing a ſtrait Line of the Length of the Timber from the Keel to the Top-timber Head. Divide that

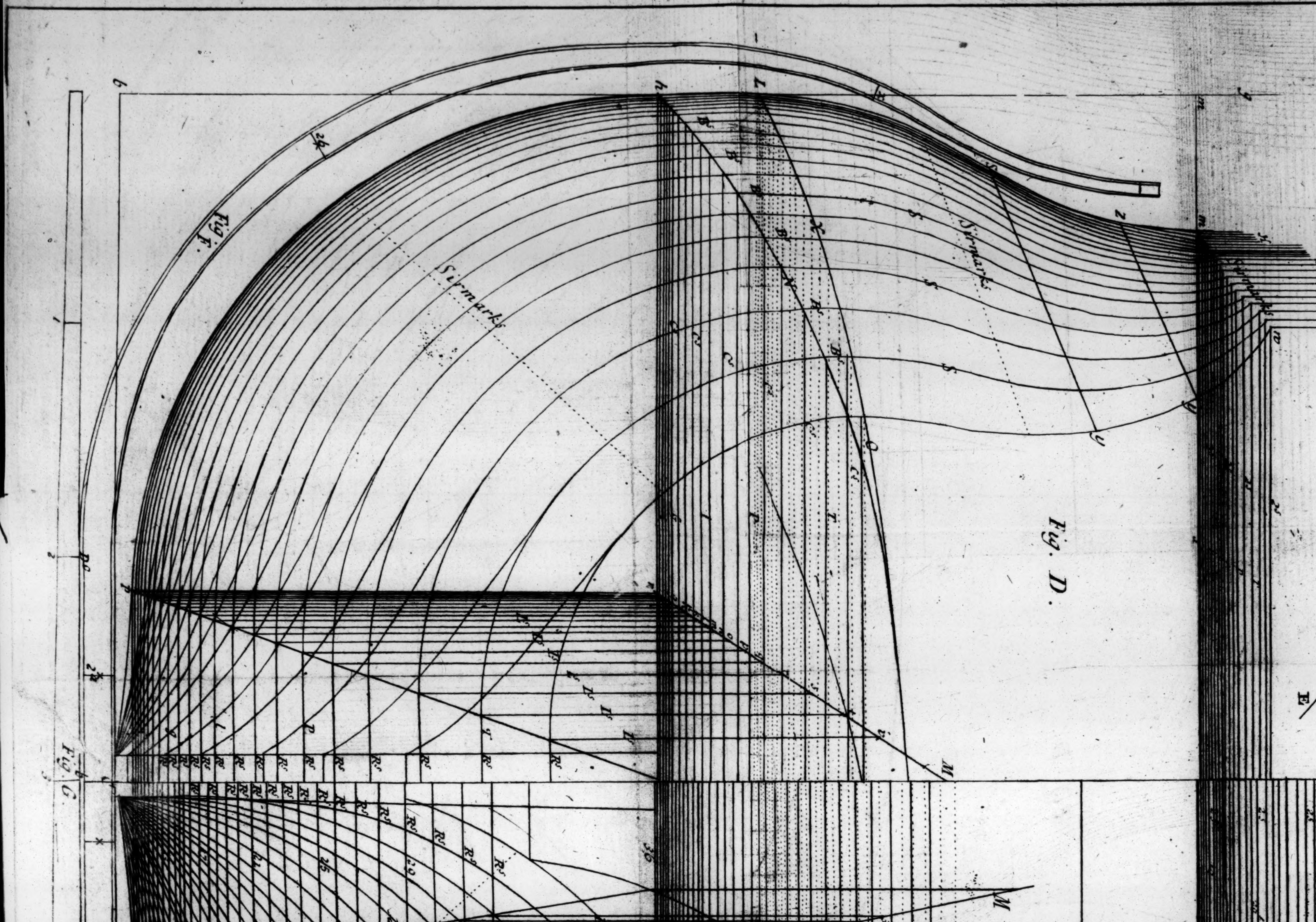
Fig. D.
Fig. F.
Fig. G.
Fig. E.
Sirmarks
Sirmarks
Sirmarks
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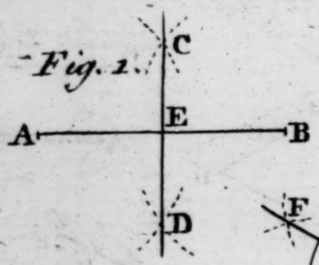
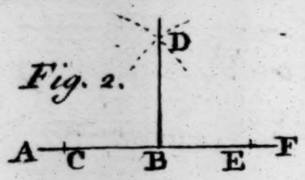
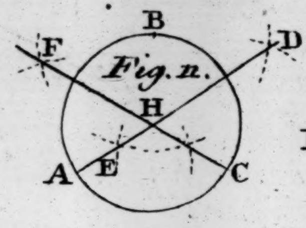
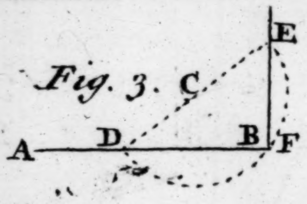
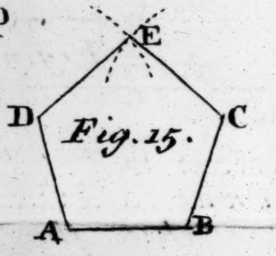
Plate I. *Facing Page 58.*

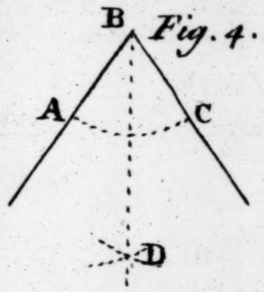


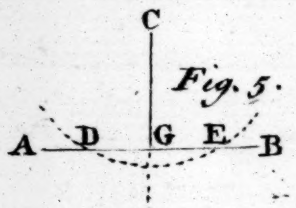


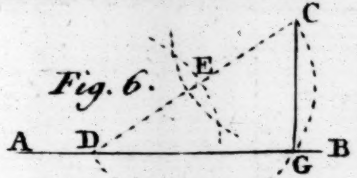


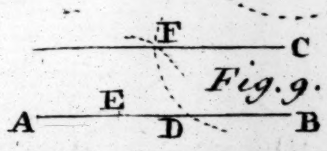


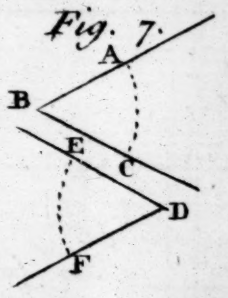


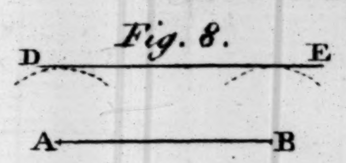


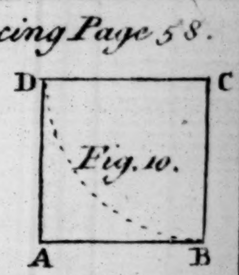


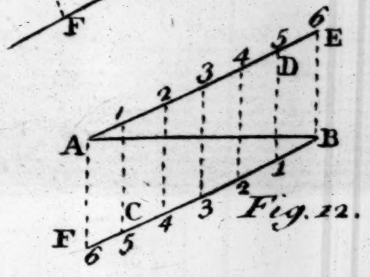


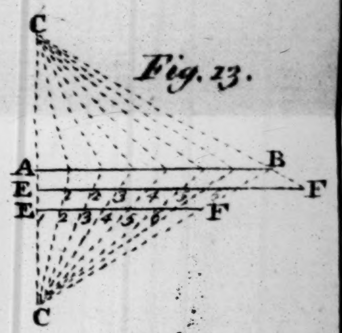












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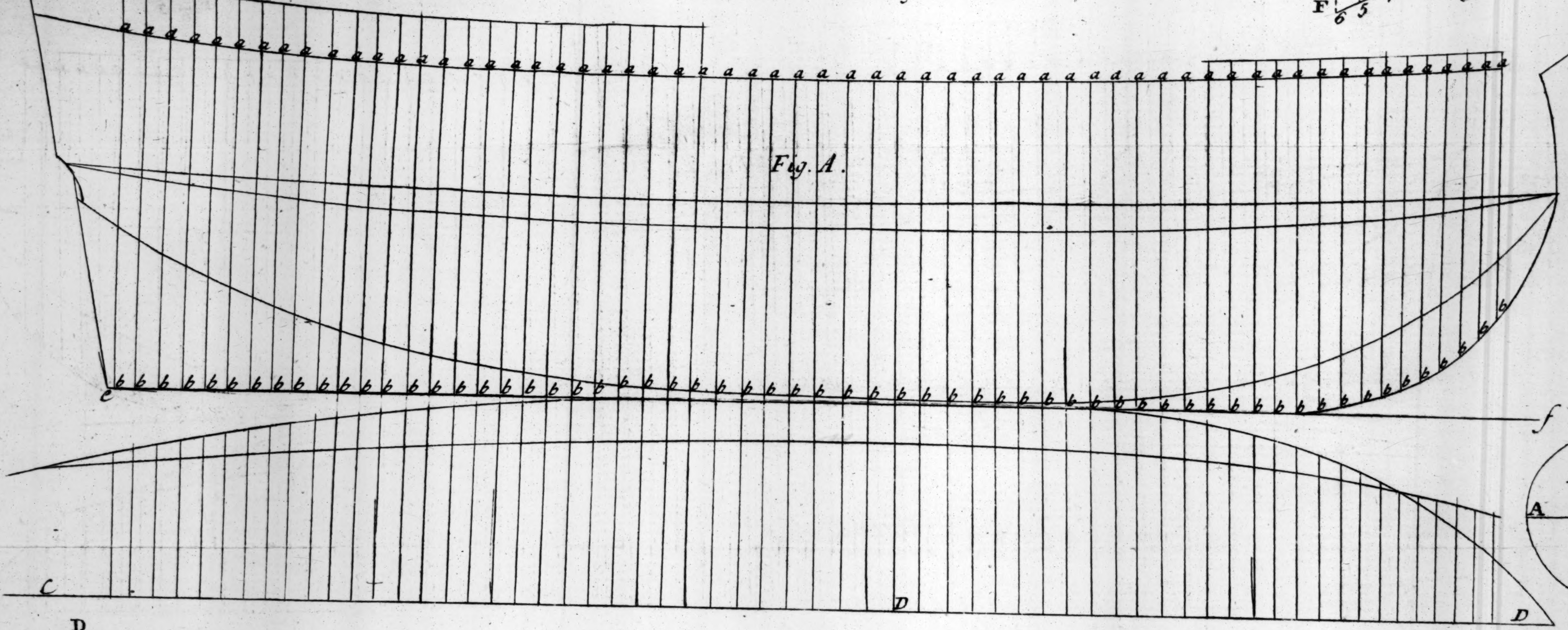
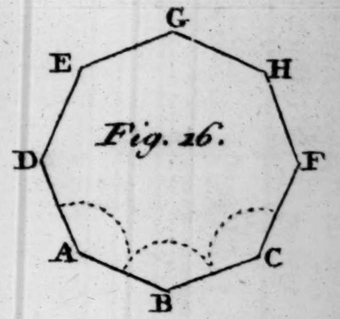
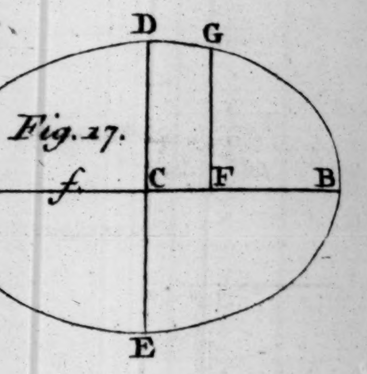
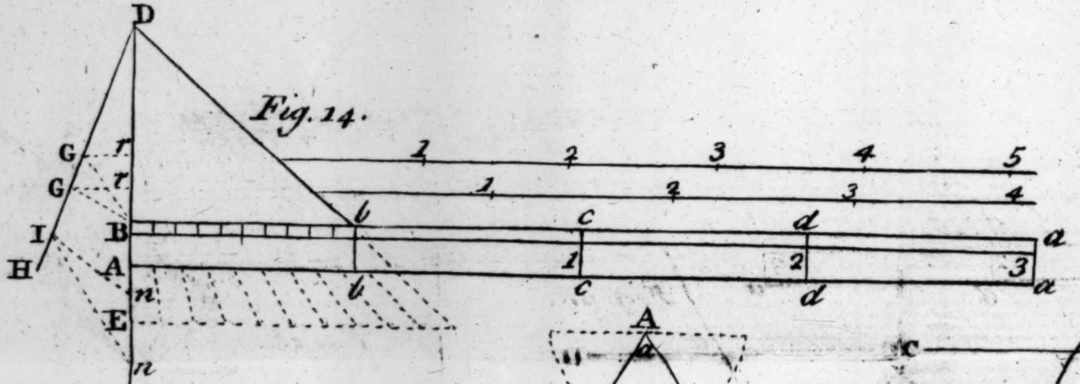
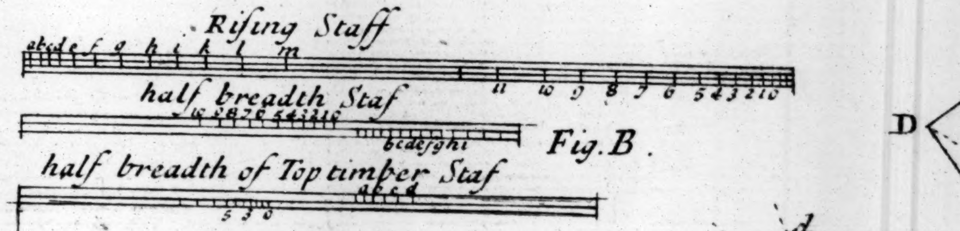
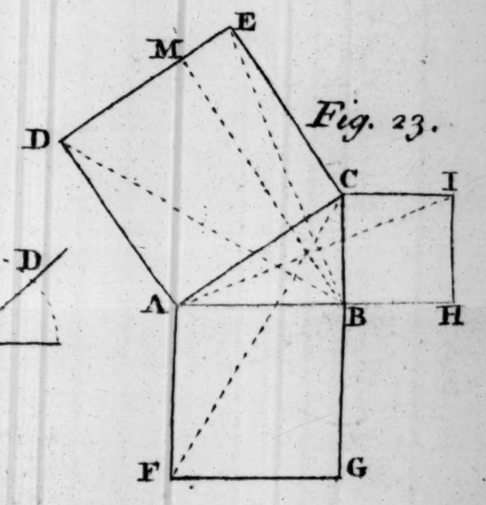


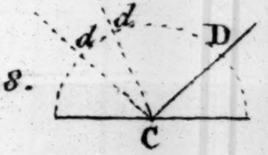


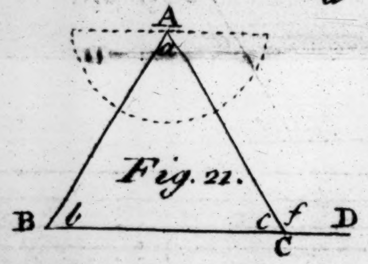


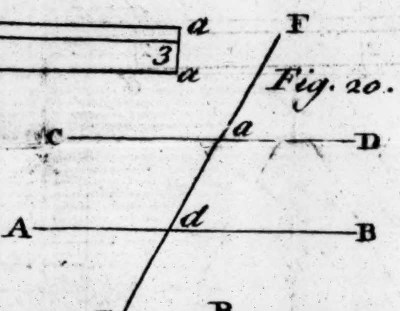


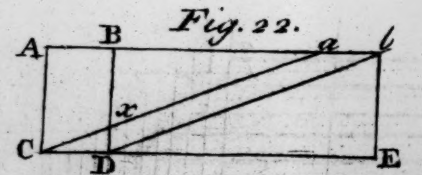


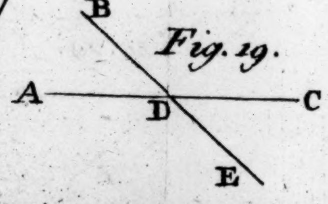












that ſtrait Line into any Number of equal Parts, and alſo the Ring made by the Ship's Body into a Number of Parts equal to that; then by ſetting off the Bigneſs of the Timber at the Floor-timber Head at the other End, it will deſcribe a Figure adapted to the Work, as in this Figure.

Diminiſhing-lines and Croſs-lines, as they are term'd, are two ſtrait Lines interſecting one another at one Part, according to the Uſe required; thoſe two Parts in Ship-building, tho' they may be thought of little Service in the Mechanic Part, yet if rightly conſidered, and well underſtood, will appear extraordinary Uſeful in divers material Pieces of Work; and ſo would ſeveral others, both in the Labour and ſaving Materials.

It would alſo be very proper to try the Ribband-lines, whether they are truly circular, according to the Shape of the Body where they are placed. Which would be a much better Method than to prove the Horizontal Parallels, or what we call making fair Water-lines; ſince the Plank is placed upon a Ship according to the Directions of the Ribbands, which is nearly ſhewed in the Figures by the Lines marked Sir-mark, or thoſe drawn at Right-Angles from every Segment that compoſes the Ship's Timbers. It alſo ſhews the true Courſe of the Water by the Ship, ſo that a great deal of Nicety ought to be uſed in adjuſting thoſe Lines, to make them truly Circular.

Such material Caſes being truly proved, and the Body adjuſted in every reſpect, a Mould or Pattern may be made for every Segment ſufficient to mark or mould out the Timbers. And the moulding the Timbers from ſuch Patterns cannot be too well performed, but ought to be done by an able and throughly experienced Shipwright, both for the Preſervation and good Converſion of the Timber; ſo that no Errors may happen, but when the Timbers are put into their Places, they may be exact and fit, according to the deſigned Shape. And no Piece ſhould be mouled ſtraiter than its Growth or natural Grain, but as circular as poſſible. Neither ſhould any Piece be taken that will work longer, or make a greater Length; but a Piece, or Chok, ought rather to be allowed at each End within. Nor ſhould large Pieces be applied to ſmaller Uſes than what is requiſite. Care ought likewiſe to be taken not to mould any Pieces that are rotten, or any way defective, both from the Conſideration of the Charge of Workmens Wages, and ſpoiling ſuch Pieces that might otherwiſe do Service in another Place.

The general Dimenſions in Ships of War, are eſtabliſhed by the Authority of thoſe appointed for that purpoſe; from whence we have a ſufficient Number of Points for determining the ſeveral Particulars neceſſary for finiſhing the Draught, in the ſame Manner as already deſcribed.

CHAP. VI.

Of laying the KEEL, *and erecting the ſeveral* TIMBERS, &c.

HAVING explained the Method of deliniating a Ship, and forming the ſeveral Moulds neceſſary for hewing the Timbers to a proper Shape; we ſhall now proceed to the Manner of erecting and placing the various Pieces of Timber, ſo as to complete this grand Machine.

The firſt thing neceſſary, is to prepare a proper Platform for ſupporting the Ship, and alſo for laying the Bulgeways on: This Platform is compoſed of ſeveral large Pieces of Timber, in proportion to the Magnitude of the Ship, and are called Ground-ways, marked *c*'s, in *Plate* 2. *Fig.* A and B. Upon theſe Ground-ways, are placed Blocks of hard knotty Stuff, to raiſe the Foundation, upon which are laid other Blocks, called ſplitting Blocks, of the freeſt Timber that can be procured, for the conveniency of cleaving out again, when the Ship is ready to Launch: On theſe Blocks the Keel is laid; they are marked *a*, in *Plate* 2. *Fig.* A. When the Keel is hewed, ſcarfed, and rabitted, it muſt be placed very ſtrait and level; and if let an Inch and a half into the ſplitting Blocks, it will be much the better ſecured in its proper Place.

When the Keel is truly placed, and properly ſecured, ſet off the exact Length fore and aft, from the riſing of the Keel, or place where its upper part ceaſes to be ſtrait, called by Shipwrights the Touch.

The exact Length of the Keel being ſet off, ſcarf the Keel to the Stem, and the Poſt to the Keel, raiſing the Stem and falſe Stern, or as Shipwrights call it, the Apron, together, if it be a ſmall Ship; and alſo the Stern-poſt, with Tranſoms or Faſhion Pieces joined together. But if it be a large Ship, then only the Poſt, or perhaps the upper and lower Tranſom, having always ſuch a regard to the Weight, that the Machine, and its Purchaſe are ſufficient for the purpoſe, without hazarding either Men or Materials. And this Caution ſhould be conſtantly obſerved through the whole Work.

Be very careful that the Stem and Stern-poſt are placed truly with the Keel, not winding in any Direction, and alſo perpendicular; which is done by drawing Middle Lines on them: That the Tramſoms are level, eſpecially the Wing Tranſom: And that all be well ſecured with Shores, placed on Timber Foundations, called Sholes, and firmly nog'd or trig'd.

In croſſing the Floor Timbers, great Care muſt be taken not to tear the Rabbit in the Keel. The Frame Timbers are to be firſt erected, which in ſome Ships is every fourth, and in others every third; but in croſſing the Floor Timbers, every other Timber is commonly put on, and bolted through the Keel. Then hang up a Ribband at the Floor Sir-mark, and if the Floor is fair, or riſes gradually, nail that Ribbon, and Shore it with Pieces of Timber, ſtout enough to bear the Weight that may be put upon them. Obſerve to level the Floor very exactly, ſince it is the firſt and principal Seat, which bears the Ship; then nog all the Shores very ſecurely, fit in all the Floor Timbers, and get in all the Dead-wood, both fore and aft. Let in all the half Timbers, and then get in your Kelſon. Be careful to ſcore the Kelſon on all the Floor Timbers, ſcarf it, and bolt it through every other Floor Timber and the Keel. The other Floor Timber were before ordered to be bolted through the Keel.

The general Method is to frame every third, or every fourth Timber; that is, to fit or join all the Foot-hooks and Top Timbers together, if it be a ſmall Ship; but if a large one, then all the Foot-hooks, to the Breadth Ribband. But in either Caſe be careful to join the Frame Timbers very exactly, and true to the Mould. Let a Ribbon be faſtened on at the Breadth Sir-mark, in ſuch a Manner, if poſſible, that you may get on one Whale, before you take it off again. When you have croſs-paled theſe Frames, ſhore the Ribbons, laying Shoals under. Then level the Sir-marks, and ſet the moulding Edges exactly perpendicular to the lower Edge of the Keel. For theſe Breadth Sir-marks being the ſecond Seat of bearing, whether they are conſidered apart, or with relation to the whole Frame, it is evident, that if the Floor Sir-marks and Breadth Sir-marks are not truly leveled, your whole Work will be ſpoiled. For let your Deſign be ever ſo good, if you neglect this Caution, your Ship will inevitably be lapſided. That is the Radii will not be equal from the Centre, and the Perpendiculars and Parallels will decline from the Horizon.

Plate 2. *Fig.* A, ſhews the Floor Timbers *e*'s placed on the Keel *m*. P, P, a Ram-line faſtened to the Stem, and Sternpoſt, and bent into a Curve, by Weights properly placed. *f*, *f*, the Dead-wood afore and abaft. *g*, the Knee on the Deadwood. *h*, *h*, *h*, *h* Tranſoms. *i*, the Faſhion Pieces. K, the Sternpoſt. *l*, the Stem. *m*, the Keel. *a*, *a*, *a*, &c. the ſplitting Blocks. *c*'s, the Ground-ways.

Plate 2. *Fig.* B, ſhews the whole Frame Bends, which are marked *a*, *a*, *a*, &c. *b*, *b*, *b*, &c. are Ribbands. C the Floor. D the double Depth Ribband, or that at the Sir-mark at the Top Timber. *c*'s the Ground-way. *d*, *d*, *d*, &c. the Shores at the Breadth Sir-mark; and *e*, *e*, *e*, &c. the Shores at the Floor Sir-mark.

CHAP. VII.

Of CONVENIENCY.

TO contrive the Cavity of a Ship in ſuch a Manner, that it may admit of the due ranging and diſpoſing of every thing neceſſary to be contained therein, is called Conveniency.

Hence a Ship ought not to be too long for her Breadth, or too ſhort for her Depth; but her Shape and Proportion adapted to the Uſe for which ſhe is deſigned.

Where there is not a Proportion of Length, Breadth, and Depth, great Inconveniency muſt be the Conſequence. For if a Ship of 20 Feet broad, can be made to perform the ſame Service, as one of 22; it is evident, that the latter will have one Foot on each Side more than the other to reſiſt her Motion. Beſides extream Breadths, as well as Depths, will cauſe a Ship to roll very much. Nor muſt a Ship have Length beyond a due Proportion; for notwithſtanding ſome have pretended that Length would increaſe Motion, yet Experience, that Touch-ſtone of Truth, has ſhewn, that they are miſtaken. And it muſt be conſidered, that a more than ordinary Allowance of Timber is requiſite to make extremely long Ships equally as ſtrong as ſhort ones. Beſides, Sir *Iſaac Newton* has demonſtrated, that the Solid of leaſt Reſiſtance is bluntheaded, and conſequently extreme Lengths will be Uſeleſs in forming Bodies for dividing Fluids.

Theſe are the principal Things requiſite to be conſidered, in order to complete this Part; but with Regard to the others they may be differently extended according to the Uſe the Ship is intended for; ſome Ships requiring to be deeper in the Hold than others, and perhaps that Depth may be ſpared out of the Height between Decks.

Obſerve that the Keel, Stem, and Stern-poſt are properly adapted to the other Parts; ſo that the Floor Timbers, Deadwood, and Tranſoms may be firmly bolted, the Rudder well hung, and the Breaſt-hooks, and Knee of the Head, if any, may be well ſecured: That the Rabbits cut in the Keel, Stem, and Stern-poſt, be ſuitable both for the Planking, and to anſwer the Faſhion of the Body in every reſpect; that the Stem be made fit to lay the Bowſprit in aloft, and to ſecure the Stay of the Main-Maſt; that the Scarfing and Over-launching of all the above Parts be duly conſidered; that all the Timbers are carried up with equal Room and Space, that one part of the Ship may have exactly as much Timber as the other, and not to continue them joined in one Place, and 6 Inches aſunder in other places; but that after the Frame Timbers are fixed in their proper places, and truly ſet, they may be parted without Prejudice, and equally ſpaced, as the Ship is planked; that there are no Side-round Timbers, but exactly ſtrait, except for the conveniency of putting them clear of the Ports, which is a very material Point, and ſhould carefully be obſerved, otherwiſe you may be obliged to cut ſeveral good Top-Timbers to make Port-holes, and put ſhort Stumps in their Room.

Let your long Timbers be ordered forward after ſuch a Manner, that they may rake forward, one after another, and take up as much Room and Space at the Head as at the Foot. Alſo turn or cant them forward, as much as poſſible, to ſave the leveling of the Timber, and that the Hawſe-pieces may have Room to have a ſufficient Scarf downwards. Obſerve carefully that the Bows of the Ship are exactly ſimilar, that the Harpings are equal, that the foremoſt Timbers ſtand at an exact Diſtance, both from the Middle Line, and from the Stem; which will cauſe the natural Tendency of the Ship to be direct, and conſequently increaſe Motion.

Let the Beams pillar on the fore Riders, and proper Hatchways be made, which are neceſſary for Lading and Unlading.

The Well is always near the Main-Maſt, and ſo are the Pumps; but if they are Chain-pumps, they muſt ſtand clear of the Main Step, and have Room ſufficient for rieving the Pump-chain. In a Man of War, the Rooms for the Powder, the Gunner's, Boatſwain's, and Carpenter's Stores are made forward, and extraordinary care taken, that the Powder-Room may be intire, double lined, and well plaiſtered with Mortar between; and a due Conſideration had to the Quantity and Quality of each Officer's Stores; and that they may have neceſſary Diviſions, or Apartments: That the Orlapſes and Platforms are of ſuitable Lengths and Breadths for coiling the Cables on, partly afore, and partly abaft the Main-Maſt; that there are Rooms quite abaft for the Bread, and next to the Bread-Room, a Room for Oatmeal, Fiſh, Butter and Cheeſe. A Steward's Room, Captain's Store-Room, a ſmall Powder-Room, the Purſer's and the Surgeon's Cabin, and a Cockpit for the Conveniency of the Men's taking their Proviſions from the Purſer's Steward, and alſo a ſmall Slop-Room. But in Merchant Ships, the Hold, or all below the lower Deck, is reſerved for ſtowing the ſeveral Commodities according to the Voyage.

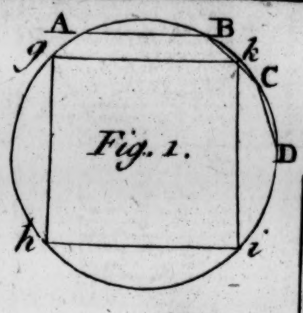


Fig. 1.

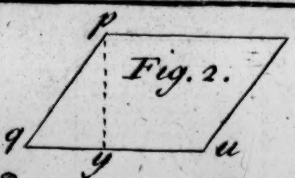


Fig. 2.

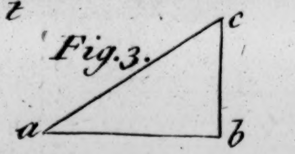
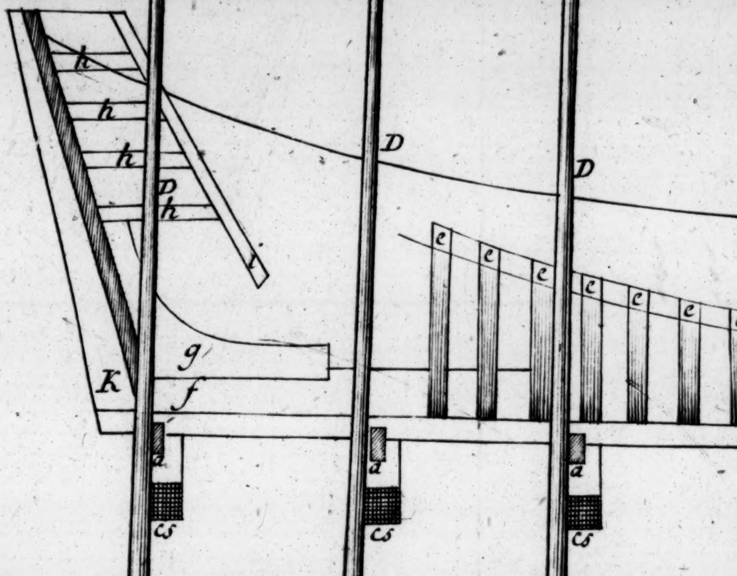


Fig. 3.



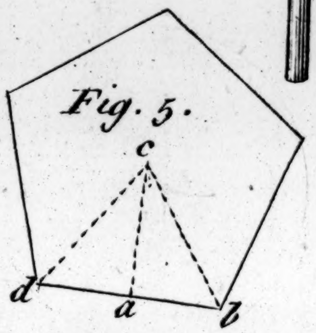


Fig. 5.

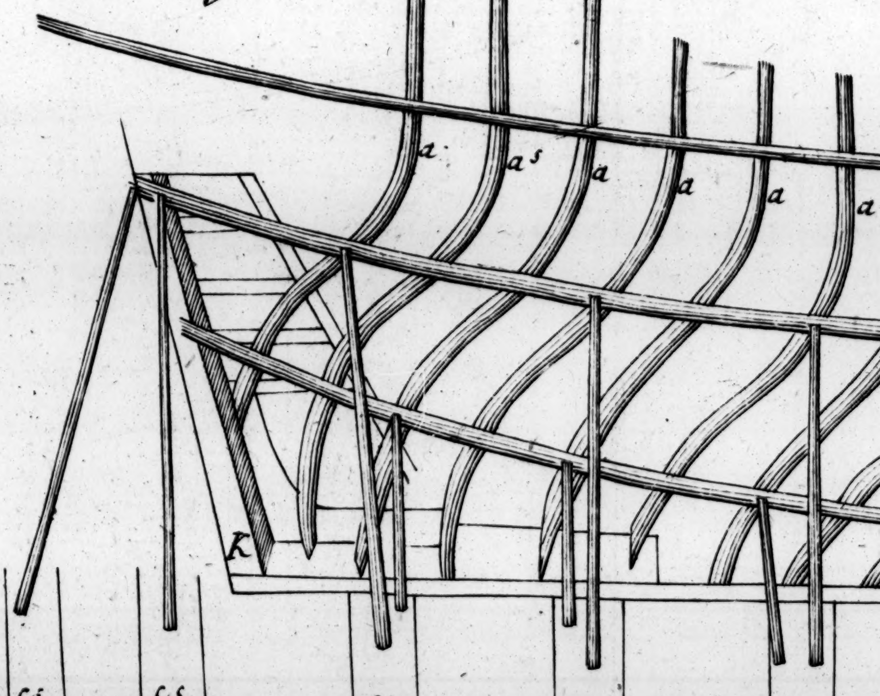


Plate II. Facing Page 64.

Fig. 4.

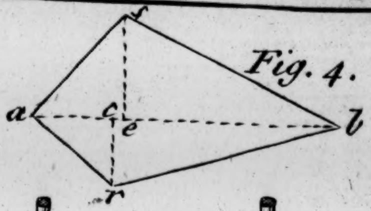


Fig. A.

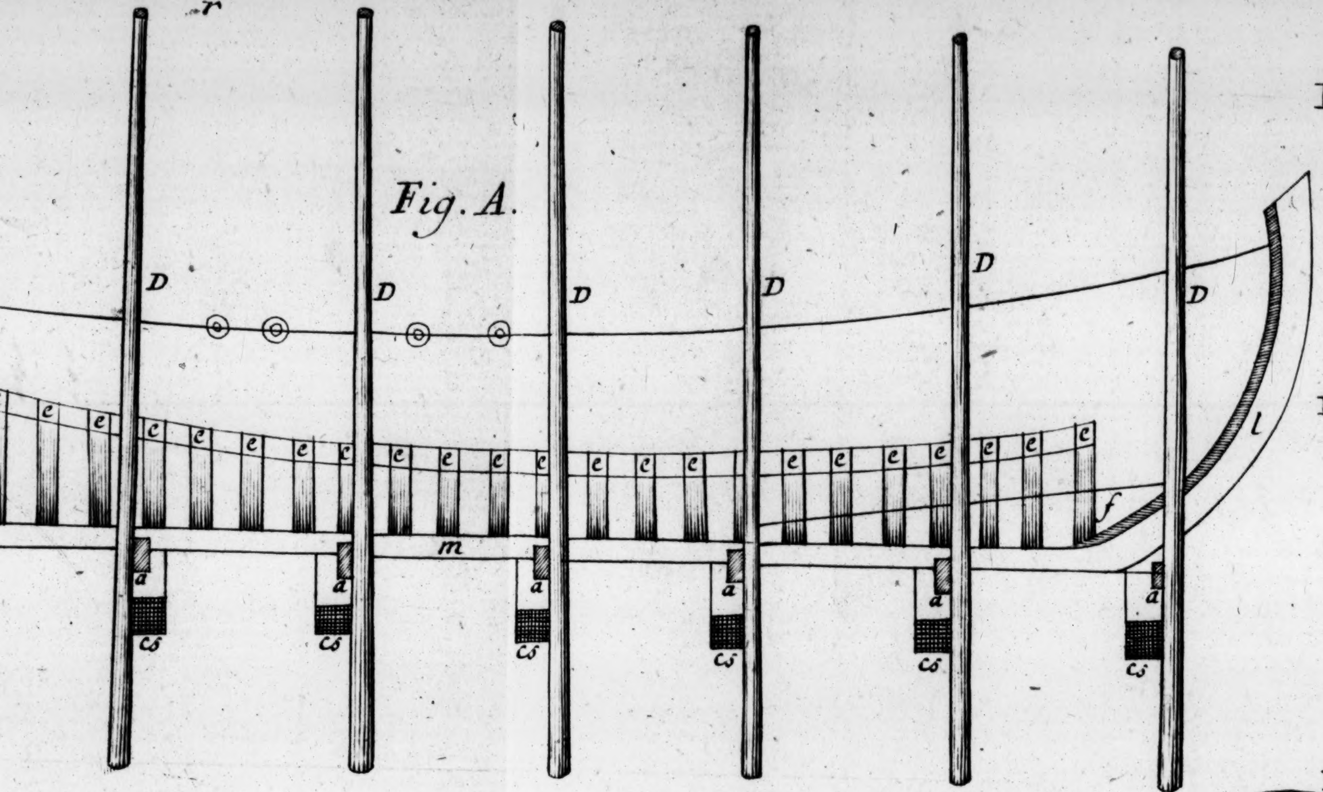


Fig. 7.

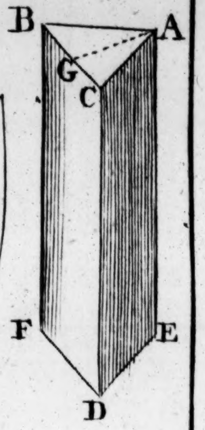


Fig. 6.

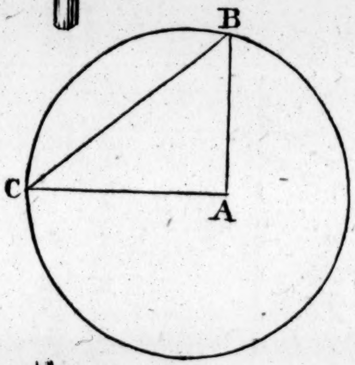
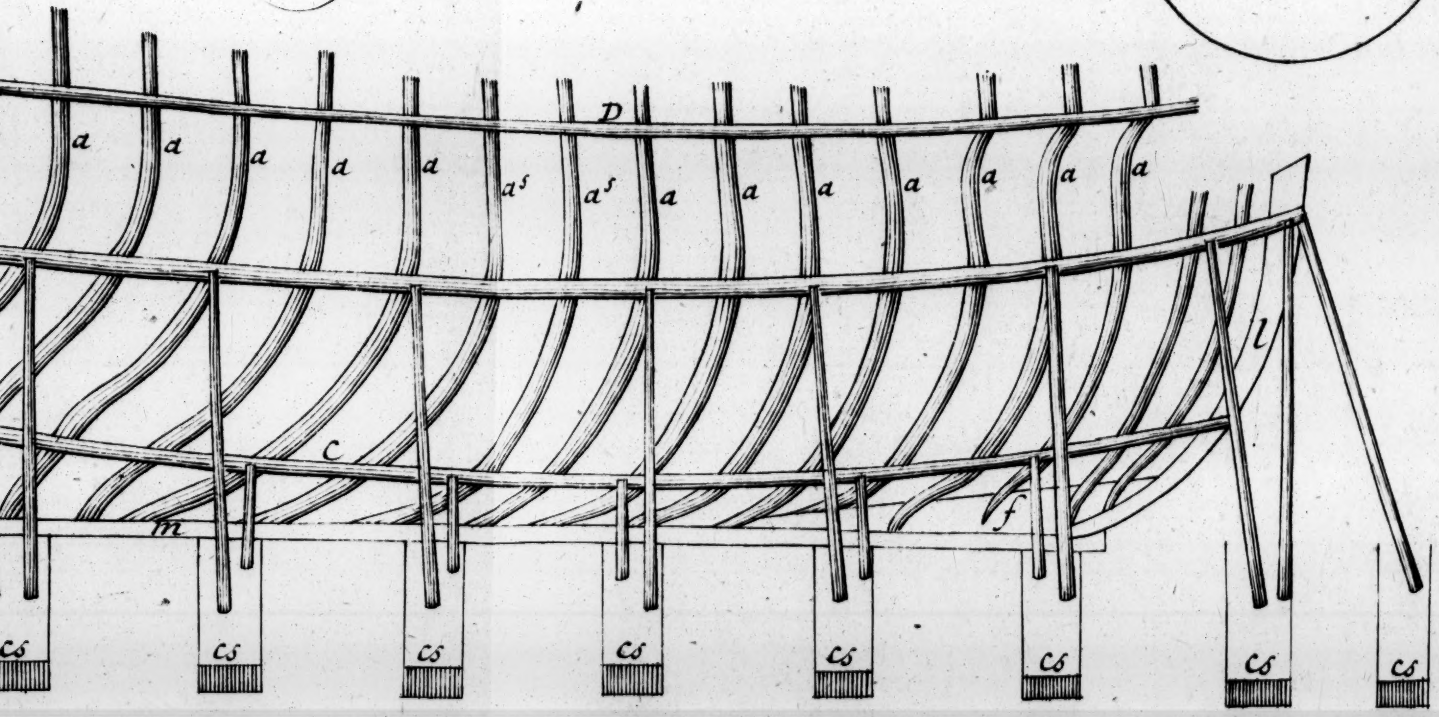


Fig. B.



Upon the lower Gun-Deck in Men of War, there is an Apartment for the Gunner, for fitting and ſecuring all his ſmall Stores, called the Gun-Room. Forward there is what is called the Manger; its Uſe is to receive the Water ſhipt at the Hawſe-holes, and prevent its running into the Ship. All Men of War above a ſixth Rate have both theſe; but there are often other Apartments, which being various, and differently placed, according to the Pleaſure of the Commander, and Magnitude of the Ship, it is unneceſſary to give any farther Account of them.

It ought always carefully to be obſerved in ſpacing the Beams of each Deck, that the Knees of each Beam be placed clear of the Ports, that there may be no Occaſion for uſing Dagger-Knees, or thoſe which are crooked, as they are neither ſo ſtrong, nor ſo eaſily purchaſed as thoſe which are ſtrait. On the Middle Deck, in Ships that have three Decks, the Furnaces are placed; but in thoſe which have only two, they are placed in the Fore-Caſtle.

The Bulk-heads ſhould be fitted in ſuch a Manner, that they may be ſecure for a cloſe Fight, and at the ſame time not embaraſs or hinder the Men in ſecuring the Maſts, or traverſing the Yards; but that every Rope requiſite for haling or handling the Sails or Rigging may be readily come at, ſecured, and faſtened.

A due Conſideration is alſo requiſite in placing the Blocks for the Main and Fore-ſheets, and alſo for tacking the Clews of the Sails, and Blocks for the Clew-lines, Bunt-lines, Leech-lines, Hallyards, Bow-lines and Braces, and, in ſhort, every other Rope requiſite in ſailing the Ship; to bring all the Purchaſes clear of one another, and that the Angles of Purchaſe may be as obtuſe as poſſible, for the facility of moving the Reſiſtant with a ſmaller Force: Channels ſhould alſo be fixed without Board, of ſufficient Strength, and well ſecured by Spurs or Knees, that they may be able to reſiſt the Power of the Wind on the Maſts, Sails, and Rigging. To the Channel-wales are fixed Plates of Iron, called Chain-plates, and Dead-Eyes, bound by thoſe Plates; through the Dead-Eyes, the Lanyards of the Shrouds are reeved, which are ſpread by the Channels. Theſe Shrouds and the Stays are the Ground Tackling, the grand Security of the Maſts, and, therefore, ought as near as poſſible, to be placed in a circular Poſition, that they may be equally affected by the Strain. Back-ſtays are to be faſtened down to the Channels, or to Stools fixed for that purpoſe.

Care muſt be taken to have Conveniencies for hoiſting in the Guns, Proviſions, Boats, Anchors, &c. to have Bolts to hook the Gun Tackles to, and Breeching, with an Eye-bolt to every Gun, for laſhing up the Muzzle; to have Stopper-bolts for the Cables, and Bolts for laſhing the Boats on the upper Deck; to have Bolts for the Top-tackles, ſtand Ports of the Sheets, and Shank-painter Chains; to have Ranges, Kevels, and whatever elſe is requiſite of that kind, for the more eaſily and handily ſecuring, and faſtening the reſpective Ropes belonging to every Sail and Utenſil neceſſary and convenient for working and ordering the Ship.

As it is abſolutely impoſſible to ſhew the whole Contrivance of ſuch a noble Structure as a Ship, and the various Parts requiſite for her Uſe, at one view on a Plane, eſpecially on one laid down from ſo ſmall a Scale, we have divided it into ſeveral. *Plate* 3. *Fig.* A. is a Section of a Ship, having three Decks, or Platforms for Guns, and only ſhews her Frame, containing the Keel *a*, Stem *b*, Stern-poſt *c*, Dead-wood D, Tranſoms *e*, Faſhion-pieces *f*, Hawſe-pieces *h*, and the Floor, Foot-hooks, and Top-timbers; which Timbers ought firſt to be equally ſpaced, as repreſented in the Figure. By ſpacing is meant, that, in Proportion to the Magnitude of the Ship, there be an Allowance made for two of the firſt Floor-timbers, beſides a Vacancy between them for the Air. Formerly, indeed, it was the Method to put the Ground-timbers, *viz.* the Floor and Lower Foot-hooks cloſe together; but Experience having diſcovered, that this cauſed Putrefaction, and was alſo prejudicial in over-ſcantling the Ships, it was left off.

But what is moſt Material, and ought chiefly to be minded in placing the upper Foot-hooks and Top-timbers, is to put them clear of the Port-holes, to ſpace the long Timbers *i*, forward equally, to make Room for the Hawſe-pieces, which ought to be well ſcarfed downwards, for Strength to the Bows. By ſcarfing is here meant to have a ſufficient Length of Timber below the Center of the Hawſe-hole *k*, or Center of the Strain; but in general ſcarfing is uſed for ſplicing, or faſtening one Piece to another.

Let the Top-timbers be placed as near as poſſible to make the Sides of the Ports, that the laſhing Bolts for the Guns may be drove through the principal Timber, and that they may give Scarf to the Port-holes; which may be done by marking the Port-holes on the Breadth Ribbands *g*, *g*, before the Ship is planked. And if it be found that the Timbers exact Place be in the Wake of the Port-holes, and that there be not Room ſufficient for placing them otherwiſe, a crooked, or Side-round Timber, that will caſt itſelf clear, ſhould be uſed; for all Timbers are placed exactly perpendicular to the Keel.

Plate 4. *Fig*. B, is a Section, repreſenting the Contrivance of cutting the Port-holes, and placing the Beams, the former of which are marked *u*, and the latter *x*, in the Figure. The hanging Knees are placed in the ſame Poſition with the Timbers, being bolted both to the Beams and Timbers, for holding the Beams to the Sides. The Beams ought to be placed one between, and one under the Ports of each Deck, with this Caution, that the hanging Knee may be placed clear of the Ports, and the lodging Knees abaſt the Beams, forward, and afore the Beams abaft, for the Benefit of making theſe Knees as much greated than a Square, or as obtuſe an Angle as poſſible, for the eaſineſs of procuring them. Beſides, in not regarding the exact ſpacing of the Ports and Beams, another Inconveniency happens, which is to have Dagger-Knees

The Beams ought to lie as near as poſſible under the Ports, to ſupport the Recoil of the Guns when fired, and alſo to lie one exactly over another, that they may ſupport each other with Pillars placed perpendicular; the lower Beams are ſupported by the Bottom of the Ship, and that by the Water.

Another Caution ought to be in placing the Beams clear of the Maſts Places and Hatch-ways; in order thereto the Main Hatch, which is the principal, ought to be as near the Middle of the Ship as poſſible; and alſo that the Place of the Main-Maſt *c* be near the Hatch-way; the other Hatch-ways are always made according to the Uſe the Ship is deſigned for. But the Maſts Places and Main Hatch-way are general, and founded on a Cuſtom, that from the Length of the Ship the Diſtance is ſet off from the Stem for each Maſt's Place; this is for a Three Maſt Ship. All other Ships or Veſſels have the

Centers of the Maſts aſſigned ; bu t all proceeds from Cuſtom, or Fancy of the Manager, as alſo Hatch-ways, that the Lading and Unlading of the Ship may be performed with as much Facility as poſſible, both to the Eaſe of Men, and Wear of the Ship.

g, are Riders placed to ſcarf the Floor and lower Foot-hooks, and called Floor-riders. They are of great Uſe in Grounding, eſpecially when they have croſs Pillars ſet upon them. There are alſo lower Foot-hooks Riders to ſcarf the Floor-timbers, and ſecond Foot-hooks. For 'tis certain, if a Ship could be built with one Piece, ſhe would be much ſtronger than to have a great many Pieces, ſince at the Head and Feet of each Tire of Timbers, half is cut off.

i, Breaſt-hooks placed in the Breaſt, or foremoſt Part of the Ship, to hook or tie the two Sides of the Ship together.

K, is a Piece of Compaſs Timber, propoſed to ſcarf the Keel and the Stern-poſt together, in the lieu of tenanting the Poſt into the Keel.

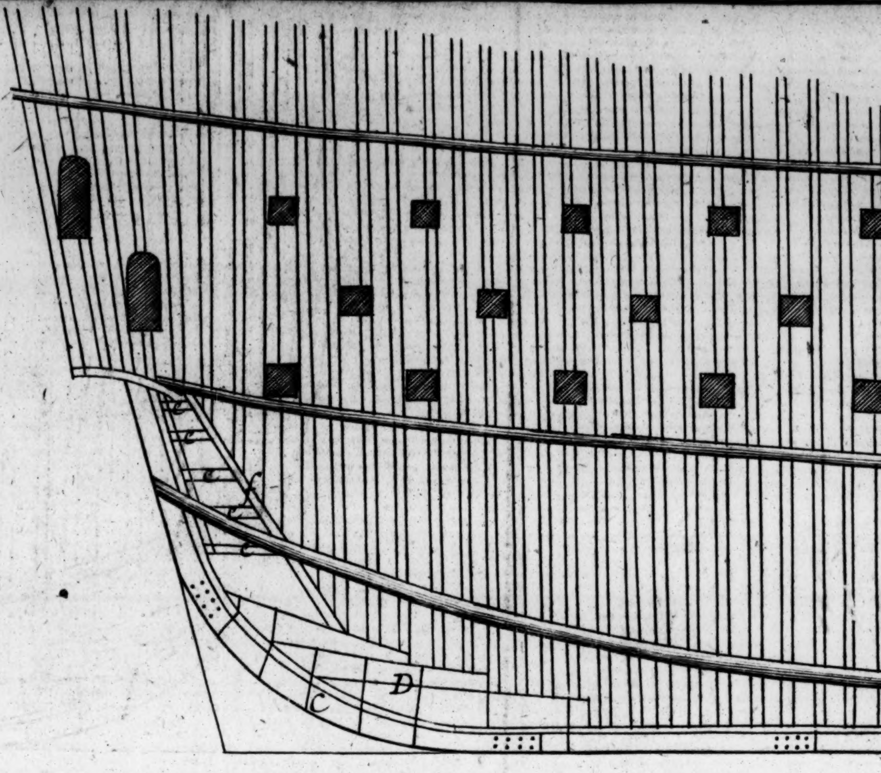
a, are lower Wales, which ought to be placed after ſuch a Manner, as to bind, ſtrengthen, and be bolted through moſt of the Gun-Deck Knees. For ſince the Breadth of any Ship is conſidered as the Place of the greateſt Strain, being that Part which makes a Diviſion of the Wind and Water ; as the Impulſe of Wind forces againſt the Sails, ſo the Water on the other Hand ſupports the Ship, and keeps her as much as poſſible in her natural Poſition.

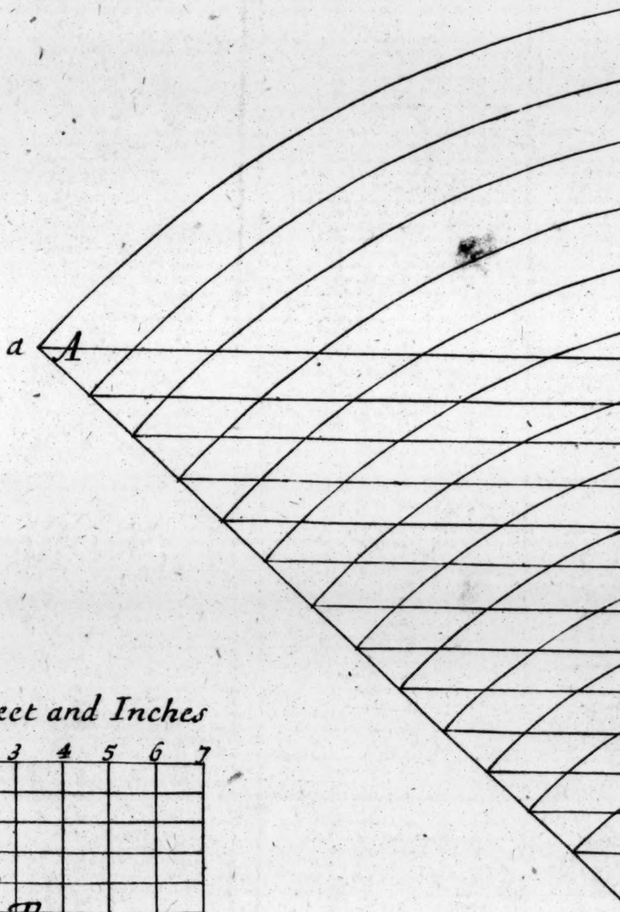
The Wales ſhape the Ship, making her look regularly curving and lively, and ought to be ſcarfed clear of the Scarfs of the Clamps within board.

b, are Channel-wales lying in the Midſhips, to make the lower Ports upper Part. The Channels for the Shrouds are placed upon the uppermoſt of the Channel-wales, and the Chain-bolts are drove through the lower one.

P, is the Poop, and *Q*, the Fore-caſtle. *O*, the Quarter-deck. *M*, the upper Gun-deck. *N*, the Middle, and *L*, the lower Gun-deck. There is another Plan under that, which is the Orlope or Platform.

e, are Bit-pins, on which the Cables are faſtened. *R*, the Bow-ſprit, or a Security for the other Maſts.





A Scale of Feet and Inches

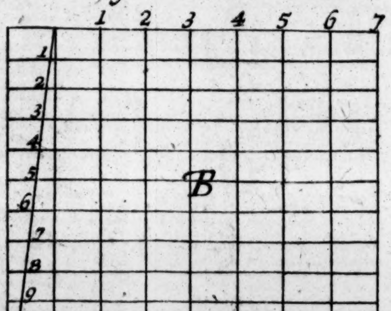


Fig. A.

Plate III. *Facing Page 68.*

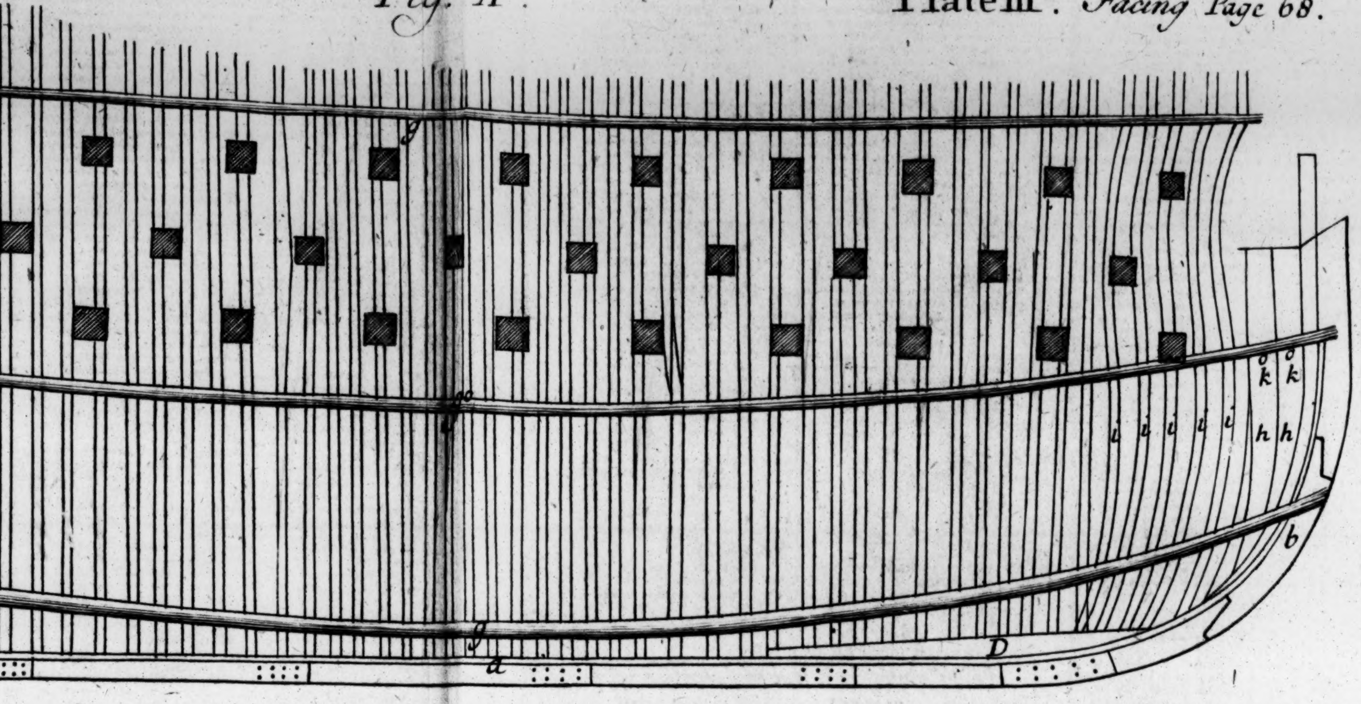
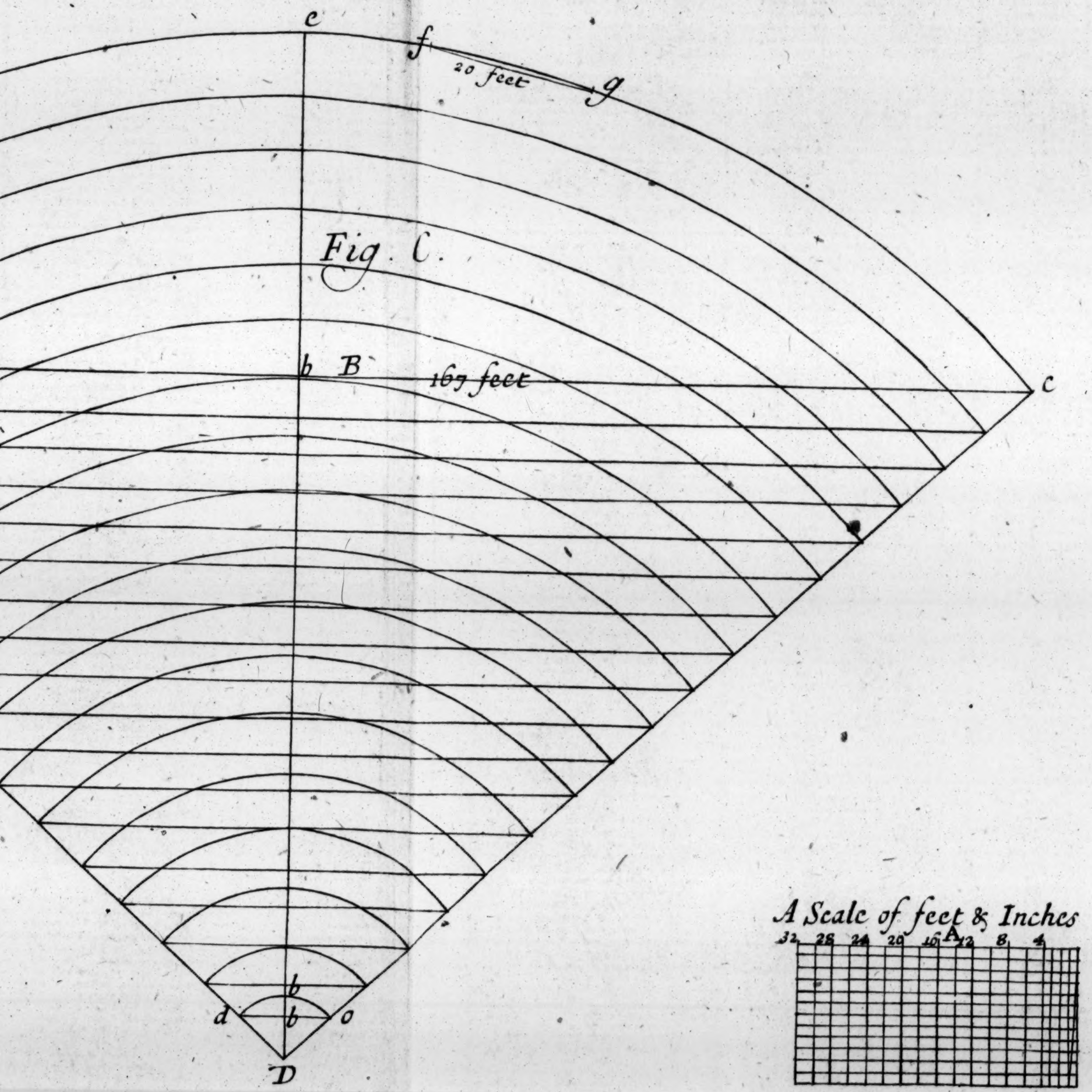


Fig. C.



A Scale of feet & Inches

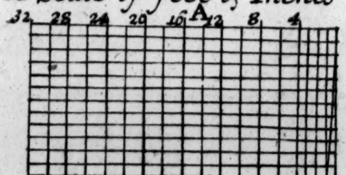


Plate 4. *Fig.* G, is a Plan of the Orlope, on which are placed the Store-Rooms, Cables, and ſeveral Officers Cabins; which Plan divides the Hold into two Parts, for the Conveniency of keeping dry Goods from Wet. *a*, is the Main Hatch-way; *b*, the Center of the Main-Maſt; *c*, the after Hatch-way; *D*, the Flag Officers Store-Room; *e*, the Captain's Store-Room; *f*, the Surgeon's Cabin; *g*, the Center of the Mizen-Maſt; *h*, the Steward's-Room Scuttle; *i*, the Fiſh-Room Hatch; *K*, the Steward's Room; *l*, the Purſer's Cabin; *m*, a Slop-Room; *n*, the Surgeon's Mate's Cabin; *o*, the Bread-Room; *P*, the Sail-Room; *Q*, the Boatſwain's-Store-Room; *S*, the Gunner's Store-Room; *r*, & 5 Apartments for Powder, to fill into Cartridges, and to ſecure it when filled; *u*, a Powder Trough to empty the Powder out of the Barrels, in order to fill the Cartridges. It will be very requiſite to have the Filling-Room as low as the Ship will poſſibly bear it, and to have it half in the lower Powder-Room, and half in the Store-Room, as may be ſeen in *Fig*. B. *S*, is that Apartment. *z*, *y*, & 6, are Lanthorns fixed after ſuch a Manner, that the Candles may be placed in any of them, without coming into the Store-Rooms, which is extremely convenient, eſpecially in Powder-Rooms, as has been woefully experienced. *w*, is the Carpenter's Store-Room; 1, the Fore Hatch-way. 3's are Cabins fitted by the Side, for Lodgings for the Quarter-Maſters and their Mates, *&c*. Tho' in time of Engagement the Sides in the Wake of thoſe Cabins are kept clear, for the Conveniency of the Carpenter's finding where the Shot is drove in under Water, that they may come to ſtop the Leaks.

There are ſeveral other Conveniencies for Stowage in this Plan; as Hawſers for the Shrouds, Cables, Pitch, Tar, Anchor-ſtocks, Planks, ſmall Maſts and Yards, Spars, Platforms for the Surgeon's Uſe in dreſſing wounded Men, and ſeveral other Uſes, which being ſo various, cannot be well ſpecified in the Plane, but are univerſally beneficial for ſtowing up Lumber, that could not ſo well be laid up in other Places.

Plate 4. *Fig*. D, is a Plan of the Lower Gun-deck, conſiſting of Beams, Carlings, Ledges, Knees, Partners, Capſtands, Croſs-pieces, and Bits, *&c*. *l*, Beams; *m*, Knees, as Arms to hold the Beams and Sides together; *n*, Carlings; *o*. Ledges; and the Bounding of the Plane repreſents the Ship's Sides. It has been obſervable in laying Floors in Houſes, or great Fabrics, that 'tis good Management to divide the Floors into Girders and Giſe; that in Caſe a Floor was propoſed to be laid of 4 Inches thick, being divided into Giſe of double Thickneſs, and to lie at quadruple Diſtance, the Strength would be equal, and but half that Stuff uſed; and one Girder of 16 Inches ſquare would be almoſt equal in Strength to 17 Giſe of 8 Inches broad, and 4 Inches thick; which Girder contains but half the Stuff of the 17 Giſe. But however this is in Houſe Work, where the Caſe is quite different, from the extraordinary Strain, and other Circumſtances, which ought to be throughly weighed in joining and uniting the Parts of a Ship. For here the Beams are conſidered as the principal Members that hold the Sides of the Ship together, againſt ſuch a rapid Motion, which ſometimes happens, by the extream Force of Wind, and Violence of the Sea. And the Beams are held with Knees, firmly bolted and 'clinched, the Weights of Guns carried in ſuch a Ship on the lower Deck being near 80 Tuns, beſides the Men and their Conveniencies. However 'tis one Advantage in Ships, that is not in Houſe-building, that the Decks are well pillar'd, which is a great Stiffening.

There is likewiſe a great Quantity of Timber ſaved, by dividing the Deck into Beams, Carlings and Ledges. For if inſtead of Carlings and Ledges in any Deck, there was to be a double 4 Inch Plank, then a whole Superficies of 4 Inch Plank would be more than 24 Beams of 18 Inches one way, and 16 Inches and a half the other, with ſix Tire of Carlings and Ledges ſuitable for the Work. The bigneſs of our Shiping has but 4 Inch Plank for the Flat of the lower Gun-deck, which is chiefly deſigned for Calking, to keep all dry. However this Material Conſideration ought to be obſerved in all ſuch Caſes, that the Plank be well ſupported, that the extream Diſtance may not cauſe Drumming, as the Shipwrights term it, which will not only cauſe Weakneſs where Strength is required, but alſo the Calking to drum, which will be neither ſo durable nor ſo dry, as if the Work were of ſuitable Strength.

a, is the Partners of the Main-Maſt, where the Pumps *b* are placed; *i*, the Jeer Capſtan; *c*, the Main Capſtan; *k*, the Gun-

Room; *d*, the Gunner's Cabin; *a*, a Lady's Hole, or Place for the Gunner's ſmall Stores, which Stores are looked after by one they call a Lady, who is put in by turns to keep the Gun-Room clean; *g*, is the Bread-Room Scuttle; *f*, the Gunner's Mate's Cabin; *h*, is often a Lieutenant's Cabin.

There are beſides theſe a Plane of the Middle Deck, wherein the Furnaces for boiling the Proviſions are placed, and Cabins for Lieutenants, Maſter's Mates, and Midſhip-Men. The Entring Ports are alſo placed here. The Upper Deck has alſo Cabbins for the Flag-Officers, or Commanders, Lieutenants, Boatſwains, Carpenters, and Mates; beſides neceſſary Contrivances for Rigging. On theſe two Planes you have alſo as many Gratings as can poſſibly with Conveniency be placed for cauſing Lights on the Plane below, as alſo to give vent to the Smoke of Powder in Time of Service. There is a Quarter Deck, Fore-Caſtle and Poop, with ſeveral Apartments for Officers, and Conveniencies for managing the ſailing Part. But it muſt be remembered, that all theſe Bulk-heads mentioned being Eminencies, are a great Hindrance to the Motion of the Ship, eſpecially when ſhe ſails againſt the Wind.

Plate 4. *Fig*. E, is the Bend of Timber in the Midſhip, and ſuch Bends are placed at equal Diſtance, as may be obſerved in *Plate* 3. *Fig*. A. Such a Ship has 100 ſuch Bends, only altering according to the tapering of the Ship. *g*, are Beams, and *h* Standards, bolted through the Beams and Sides. Such Knees are applied to an old Ship to ſtrengthen her. *a*, the Floor Timbers; *b*, ſecond Foot-hooks; *c*, the fourth Foot-hooks; *d*, Channel Wales; *e*, Main Wales; *f*, the diminiſhing Strakes to taper the Plank of the Bottom from 9 Inches to 4 Inches thick.

Plate 4. *Fig*. F, is a Bend of Timbers to ſhew another Part, where *m*, is Croſs-pillars, *n*, Knees. The Croſs-pillars are ſtepped, on the Floor-riders, and faſtened to the Gun-deck Beams, to ſupport that extraordinary Strain, which is cauſed by the Ship's moving, and alſo in laying on the Ground. *i*, the lower Foot-hooks; *k*, the third Foot-hooks, and *l*, the Top-timbers. In which you may obſerve, the Timbers to be equally ſcarfed, the Middle of one Timber being in the Wake of the Head and Heels of the others. *a*, is a Floor-rider; *b*, the Sleepers or thick Strakes at the Floor-heads and ſecond Foot-hook Heels; *c*, the middle Bands or Orlope Clamps; *e*, the Spirkit Riſings, which are placed under the lower Gun-deck Ports; *f*, the Middle Deck Clamps; *d*, the Lower Deck Clamps; *g*, the Upper Deck Clamps, and *h*, the Spirkit Riſings under the Middle Deck Ports.

We obſerve this Method as near as poſſible, to lay our Ships Decks one from another either exactly parallel, or diminiſhing, according to the Uſes requiſite in ſuch Decks. The Rules for doing the ſame have been always various, according to the Fancy of the Workman; ſome ſetting off the Decks, by ſtretching a Line on the Side, parallel and perpendicular from the other Decks. The lower Gun-deck is ſet off from the Keel, tho' ſome Work is ſo very exact, that they will ſet off the lower Deck from the Breadth Sir-marks.

But the uſual Method is putting up the Beam Mould at the Heights in the Middle of the Ship, and ſetting of one Height on the Stem, and another at the Stern, and ſtretching a Ramline from thoſe Heights afore and abaft, till the Line by its own Gravity touch the upper Part of the Beam Mould, obſerving that the Beam Mould be kept to its true Rounding; then ſetting off ſeveral Spots on the Side, by keeping the Beam Mould at the Side, and the Line out of Winding with all the Spots you ſet off. After you have made your Spots pretty near one to another, mark out a Red Line for the more eaſy diſtinguiſhing; then level another Line on the other Side of the Ship, from the firſt exactly out of winding, or parallel from the other.

But becauſe a Line hanging by its own Gravity cannot be truly circular, but will be rounder in the Middle than at the Extremities; therefore, after the Gun-deck is truly ſet off, either from the Sir-marks, or from the upper Edge of the Keel, it may be proper to ſet off the reſt of the Deck from the lower Plane, by Perpendiculars, and parallel Heights. The ſame may be ſaid of the Wales. The propereſt Method is to ſet off perpendicular Heights from the upper Edge of the Keel.

But the general Miſtake in ſetting off Ships Decks, is the not obſerving to ſhorten the Beams aft and afore, by which Means

Plate IV.

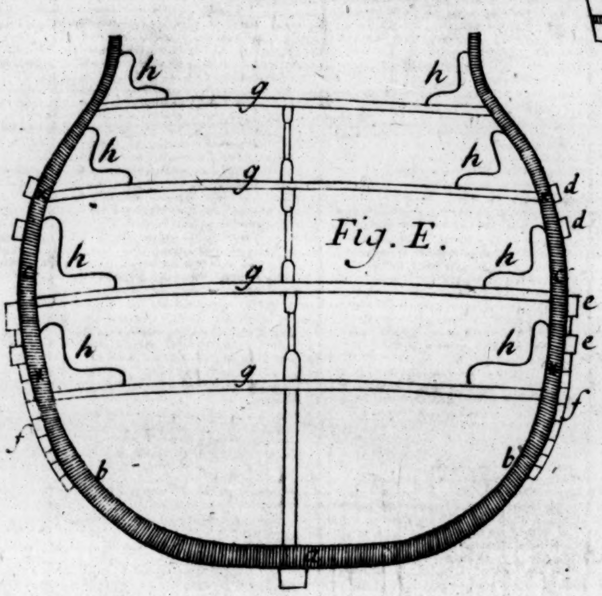


Fig. E.

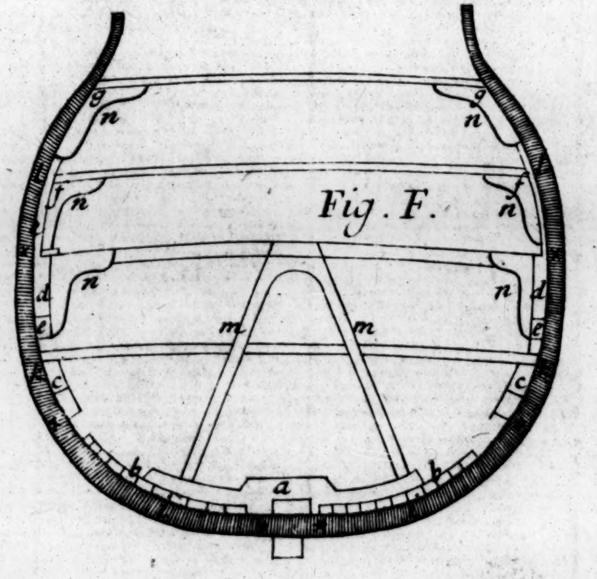


Fig. F.

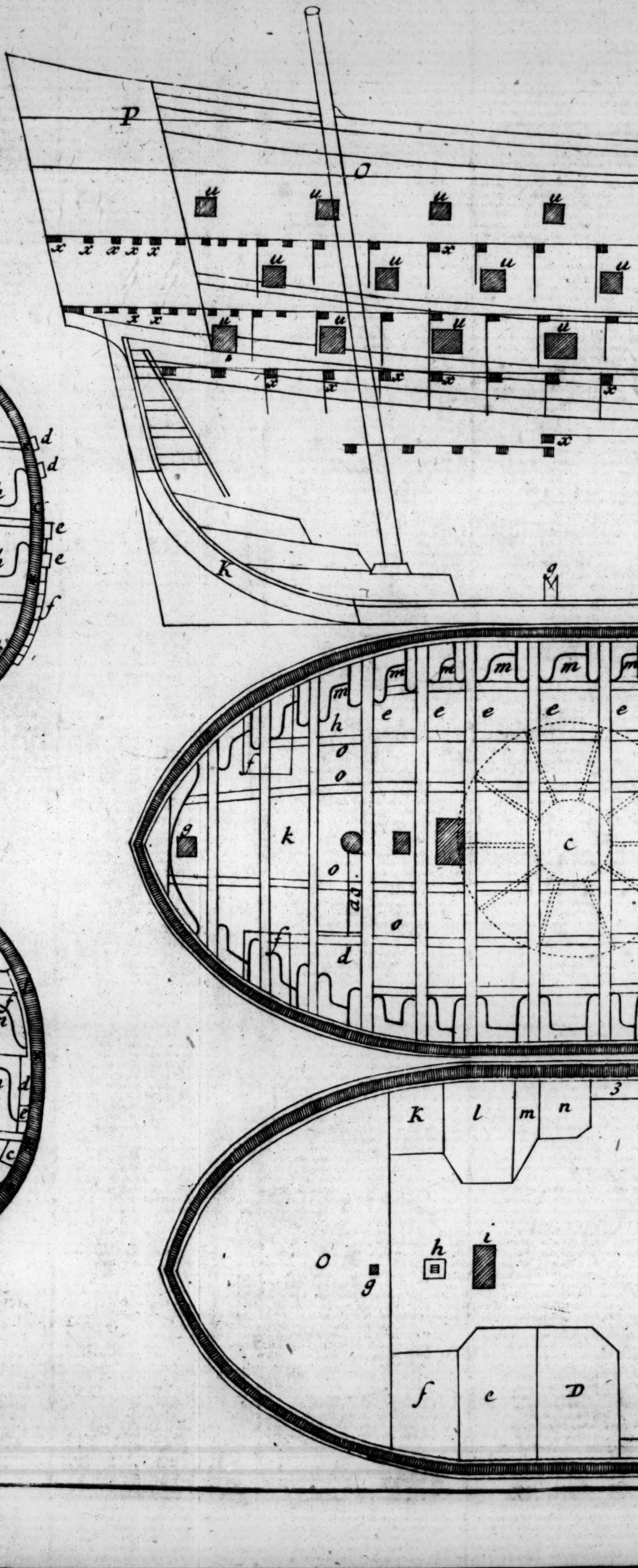


Fig. B.

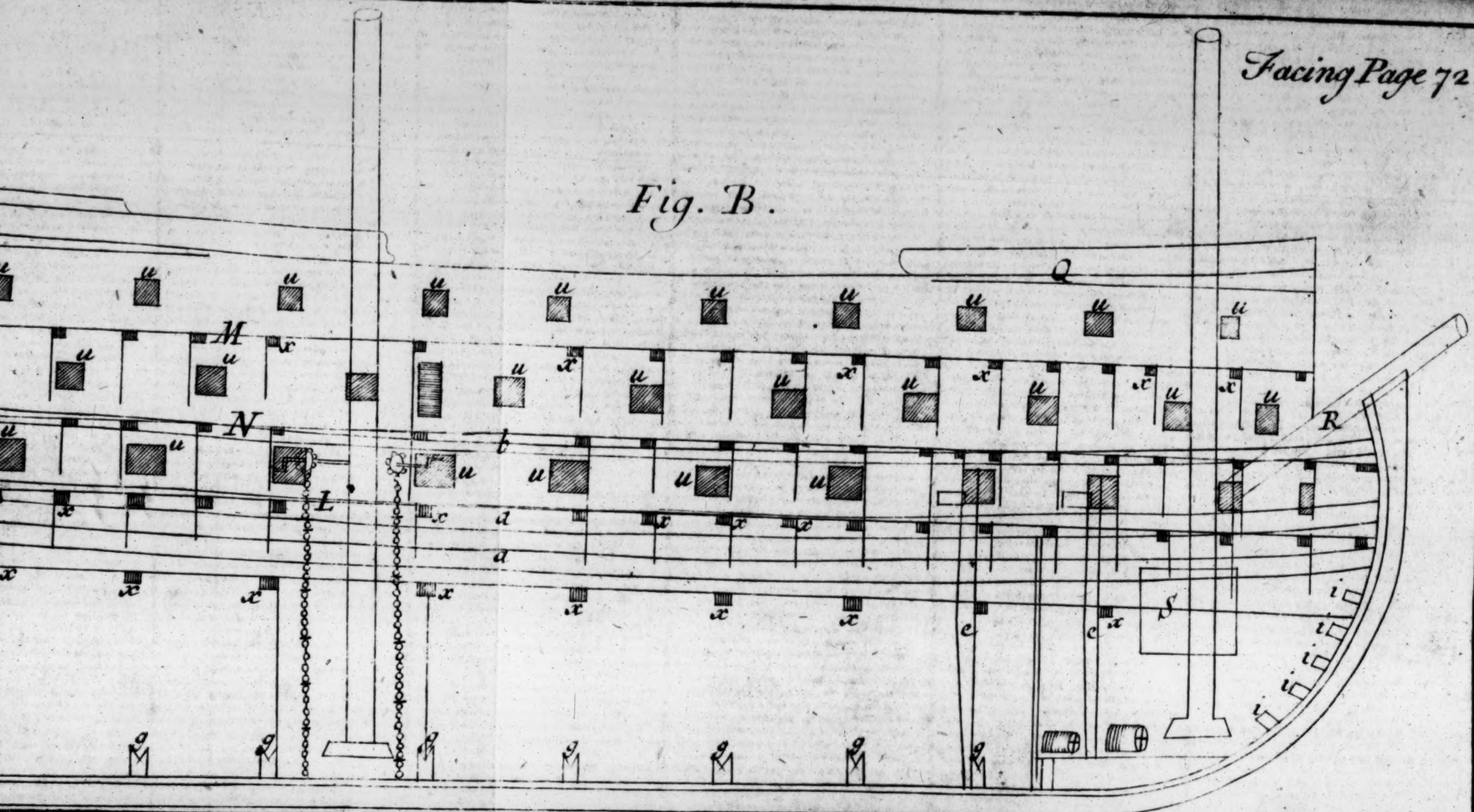


Fig. D.

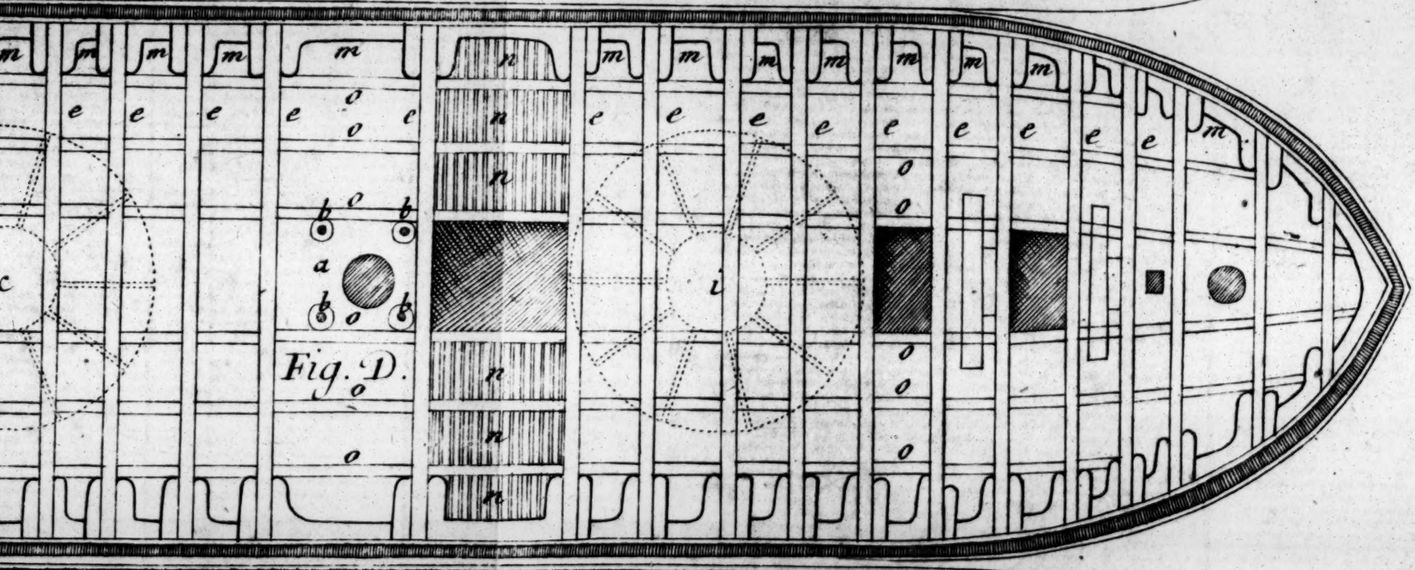
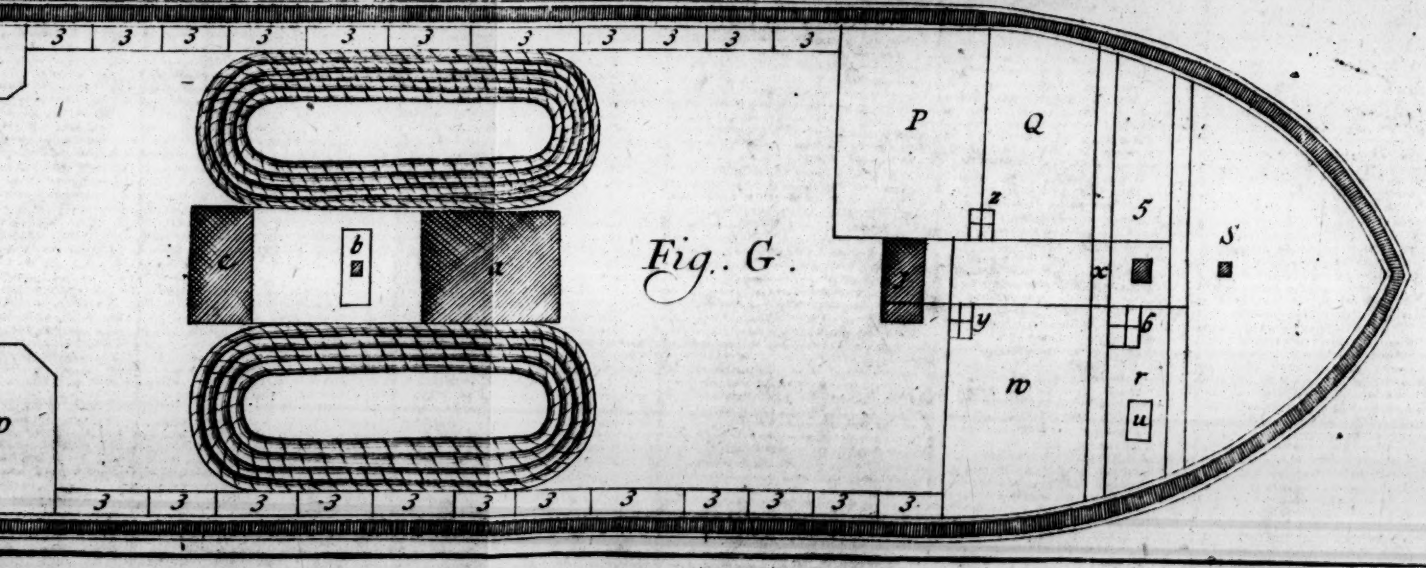


Fig. G.



Means the Decks in the Midſhips round a great deal more than at the Extremes, cauſing the Decks at the Sides, and in the Middle to be different, by hanging tranſverſly, or fore and aft.

CHAP. VIII.

Of PLANKING.

PLANKING is ſo very material a Branch, that unleſs it be well performed, all the other good Properties will be of little Uſe. But by this Term is not bearly meant the outſide Planking; but likewiſe all the Clamps, Spirkit-riſings, thick Stuff, Wales, and Channel-Wales without Board. This ought to be well performed, by joining, faſtening, and calking, and the goodneſs of every Inch of thoſe Materials carefully inſpected. The Scarfings, or over-launchings of the Planks ſhould be placed alternately, that the Ship may be equally ſtrong, and that one part of her may not be more cut or mangled than another. And in order to this the uſual way in Planking a Ship's Bottom, to leave out the Garboard Strake, or that next to the Keel; but that Strake not being eaſily ſhut in, the next is to be left out, for the Conveniency of clearing the Hold of Chips or Dirt, till the Ship is built. In ſhifting the Buts you muſt be careful to put them clear of the Scarfs of the Keel, and that a But may not be put in the Wake of the Pumps, as it may be of dangerous Conſequence, either in ſtraining the But, or ſucking the Oakum out of the Seam.

Regard muſt alſo be had to the Lengths and Breadths of the Plank you intend to Uſe, that the Rabbit of the Keel, Stem, and Stern-poſt, may be made exactly to fit your Plank. The Length of the Plank you have to Work, is chiefly to be obſerved; for if you cannot continue working up to lower Wale, with the ſame Lengths you begin with, you will certainly be at a loſs, and have worſe Work upwards in ſight, than you have lower down.

The Breadths ought to be conſidered, and alſo the Faſhion of the Plank. For if you deſign to bring every Strake of Plank to the Stern, you muſt obſerve the Shape of the Ship's Body; ſince it will be very difficult to do it in ſome Ships that have large Floors and full Bows. It is therefore very cuſtomary in many Ships to drop or ſteal, as they term it, ſome Strakes ſhort of the Stern, and raiſe what you can regularly in the Bulge and Loof. You will likewiſe be obliged to have ſnying (or crooked) Planks to continue the Cuſtom generally practiſed. However, let the Cuſtom be as it will, as much as poſſible keep your Work from extream Snying or Cambering.

The after Part of the Ship ought alſo to be minded, where the Ship's Body is a hanging Conoid, and the Tangent-line perfectly ſtrait, by which means moſt Ships have Hollows ſo long and deep, that you cannot well work the after End of the after Planks too broad, to bring the Plank's Edges ſtrait, that they may lie on a direct Plane, out of Winding.

The beſt and moſt proper Way is (if a Workman could be allowed ſuch a Privilege) to ſee the Faſhion of the Ship's Body, and the different Length on the Girt at every Frame Bend, or third or fourth Timber, from the Keel to the Wale. Then he might make exactly equal Diviſions, and every Plank might be of equal Breadth throughout the whole Work. An expert Workman however thinks it no difficult Matter to birth up a Ship's Bottom exact and genuine. For afterwards it is but to obſerve the true Swing of the Ship's Body, and make the Edges of all the Planks ſtrait, aft and afore, where the Edges are rounding, by regular Curves, according to the Nature of the Ship's Body. Otherwiſe the Ribbands are as good a Guide as need be, being perfectly ſtrait aftward, and will lie no otherwiſe than on a direct Plane, and afore they are rounding according to the Nature of the Ship's Body or Bow. But however, to ſet off the Height of the Wale in divers Places is very proper; for the exact Gauging of the Strakes of Plank, eſpecially upwards, where it is very commendable to ſee Work well and exactly performed.

'Tis alſo allowed in Ship-building, that if three whole Planks be wrought between two Buts, from 4 Inch Plank to the thickeſt Stuff, if one over-launch the next but 6 Feet, it is ſufficiently ſtrong. And according to this Rule 'tis generally ordered to fall out in the thineſt Plank: Tho' a nice Proportion of ſuch over-launching and ſcarfing of Plank will come neareſt to the Cube Root of the Length that each Ship is one to another. And if it is demonſtrable that by ſuch a Method, 'twill be ſufficiently ſtrong, it would be moſt proper to provide and plank Ships Bottoms according to the Magnitude and Length of each reſpective Ship that is immediately to be planked. Since the Price of Plank and Timber increaſes or decreaſes according to the Bulk or Uſefulneſs of each Piece.

But if there be a falſe Notion in converting Plank, or if it be meant rough Plank as well as rough Timber, 'tis very prejudicial and deſtructive to the Manager. For in Plank we conſider here but of two Dimenſions, Length and Breadth, ſince the Thickneſs gives it the Name of Plank, according to the Size it bears. So that Plank and thick Stuff for Ship Work may be exactly fitted to their Length and Breadth, tho' 100 Miles from the Ship they are intended for; ſince ſeven-eights of all ſort of Plank for Ship Work is a perfect Parallelopipedon, ſtrait, and of Parallel Breadth: And whoever conſiders it otherwiſe, waſtes one-third of ſuch a valuable Commodity as Plank is by falſe Converſion. Indeed afore and abaft the Plank is of another Faſhion, and is termed ſnying afore, and a ſhort turn of ſnying abaft; but however ſuch Plank may be alſo as exactly provided.

The croſs Marks are the But-Ends, which are ſhared with as much Exactneſs as poſſible, that every Part of the Ship may be of equal Strength or Weakneſs, which is cauſed by thoſe Buts-Ends; ſince equally to ſhare Buts, and work 3 whole Plank between 2 Buts, is to work all 24 Feet Lengths, and with 30 Feet Lengths 4 may be wrought between, and ſo on. Notwithſtanding a Ship will be the ſtronger for having long and broad Planks, provided they are well faſtened and joined, and continued throughout the whole Ship; if not, the Property will undeniably be otherwiſe.

At the Breadth of the Ship under the lower Wale you work 3 or 4 Strakes, diminiſhing in large Shipping, to bring 8 or 9 Inch Stuff to 4 Inch Plank.

The Plank of the Buttock, or aft Part of the Ship, is very difficult to work, by reaſon of a ſudden Round, about the

Faſhion-piece. The Plank therefore provided for that Purpoſe ought to be the beſt and choiceſt, free from Knots, or any other Defects. The Outſide of the Tree, and the Ground-end, is always beſt for that Purpoſe; and ſo for all other Plank that is much bent by Fire.

The principal Regard in planking the upper Works, is to ſhift as clear of the Port-holes as poſſible, that what Weakneſs is cauſed by cutting ſuch Holes, may be ſtrengthned by the Work that is brought on near them. The inboard Work is always allowed to contribute moſt towards the ſtrengthening, ſince it is generally thicker Stuff, and well hooked and ſcarfed. And a due Conſideration ought to be had in Planking within-board, to ſhift the Buts clear of thoſe without-board; to flat-ſcarf the Foot-wailing, that the Timber may have but two Holes inſtead of four, which would be required in working common Buts.

You muſt alſo obſerve, that all projecting Parts of ſuch Wales are laid parallel to the Horizon; tho' that Part which makes the Seam for the Oakum, is in all Work perpendicular to the Timber in the Wake; otherwiſe the Caulking would force one Plank's Edge off, and not be good Work.

Plate 3. *Fig.* C. ſhews the Method of Shaping of any Ship upwards, termed Sheering of her, the better to accommodate her to the Element ſhe is to act in, when ſo diſturbed by the Violence of the Wind, that its Waves reſemble Mountains. 'Tis then very ſuitable to the Nature of ſuch a Machine to be curved; ſince the Body of any Ship under Water is no other than a hanging Conoid, and is not ſupported by her natural Body, near ſo well afore and abaft, as ſhe is in the Midſhips, or largeſt Part of her. From whence the Weight of the Extreams will cauſe an Alteration in the Sheer, as ſoon as ever the Ship is launched, and in the Water. So that if a Ship was made perfectly ſtrait, and parallel to the Surface, ſhe would look broken backed, or to ſpeak more properly, Camber-keel'd.

The Opinion of Men in this Point has been various, both as to the Proportion of hanging in 20 Feet Length, and the Difference in the Height between the foremoſt End, and that abaft; there being an oppoſite Conveniency in the two Properties, tho' in their Nature they anſwer the ſame Effect.

It is the Opinion of ſeveral, that the quicker the Sheer is, the more it contributes to the Strength of the Ship, and makes more Heights upwards, which accommodates the Ship, as does likewiſe the laying of the Wale higher abaft than afore; ſince the accommodating the principal Officers Cabins is what is aimed at, which are always placed aft. This Property of quick and different laying the Wales will be moſt ſuitable to great Ships, which carry a great many Officers, and ought alſo to be built very ſtrong. But in ſmall light Ships, that are only built for Runners, and where perhaps there are but few Officers that expect great Apartments, the ſtraiter and ſnuger the Sheer lies, the leſs Wind is held to hinder the Motion of the Ship. For undoubtedly every Bulk head, and the Cavities which are oppoſed to the Wind, hinder the Motion of the Ship.

Therefore this Figure cannot at one View be made general, becauſe of the Variety in the curving of Ships. However, it will lead towards a Rule to make all Shipping ſimilar in their Curving, or Crookeding the Sheer, ſince 'tis an uſual Method, from a Boat of 10 Feet long to a Ship of 170, to give the Hanging either in the whole Length, or in 20, 10, 5, or any Number of Feet in Length; only obſerving that the whole Length of the Ship muſt be taken, from the Chord Lines, as *a b c*; and the hanging or rounding of the Sheer in her Length, from the perpendicular Lines, as *D b e*; and meaſured on different Scales. The Scale *A* meaſures the Length of the Ship, and the Scale *B* the Hanging. But to find the whole Hanging, from the Hanging in 20 Feet, ſquare 20, and ſquare the Length of the Ship on the hanging Line; then ſay: If the Square of 20, gives 1 Inch and a half, or any other Hanging, what will the Hanging or Crookeding of the whole Length of the Ship be?

A, *B*, *c*, are 169 Feet, the Length of the Ship on the Sheering Line, and *B*, *e*, the Hanging in the whole Length, *f*, *g*, 20 Feet, and hangs 1 Inch and a half: *d*, *b*, *o*, 10 Feet, the Length of the ſhorteſt Boat that is fit for any Service, and *b b*, 4 Inches, or the whole Hanging.

Not that this true circular Sweep can ſo correſpond, as to make an exact Sheering Line, ſince a Ship's Body conſiſts of Elliptic, or ſpiral Lines, terminating at each End in a Point.

Whatever then the Lines are, that taper the narrowing of the main Breadth (which is near the Place your Water lies againſt) the Sheering Line ſhould anſwer both to the Length and Crookeding of the ſame.

Plate 5. *Fig*. F, and G, ſhew the Shape of the Body from the main Breadth upwards; F, being the aftermoſt, and G, the foremoſt Timbers; *b* ſhews the Shape of the Wales, and how thoſe Strakes that project ſhould be managed.

Plate 5. *Fig*. 1, ſhews the winding, twiſting, or wreathing of a Ship's Timbers above Water, which is cauſed by accommodating the after Part of the Ship. And forward it's to make Proviſion to keep the Anchor from the Bow, when purchaſed by the Cat-Tackle.

Fig. 2, is the Shape of the Channel-wale at one Beveling or aft Part of the Ship, where the Timbers are near upright or level; *Fig*. 3, the Shape at the next Beveling; *Fig*. 4, the next; *Fig*. 5, the next; *Fig*. 6, the next. And after a Piece of Timber is cut to its Thickneſs and Depth, there is always left ſome Wood to work on, more or leſs, according to the Ability of the Sawyer; few of them being able to work ſo true, or make their Converſions ſo exact, as moſt Shipwrights can with an Addice. The Piece is cut in the Faſhion of a Parallelopipedon, and trimmed after that manner, and the Lengths of the Pieces ſet off on the Ship's Side. In the Length, 3, 4, or 5 Sir-marks are made, according to the Length of the Piece, and at every Sir-mark the Beveling (or Declination from a Perpendicular) is taken with a Level and Bevel, as the *Fig*. 4, having one Limb perpendicular to the other, as 14 and 15. The other Limb 6, being ſo to move, that by keeping 16 on the Side of the Timber, and 15 parallel to the Horizon, and the Plummet in 14, perpendicular to 15, then 6 gives the Declination of the Plane. When the Bevelings are taken, you mark them off on a Wedge, or Piece of Batting for ſuch a Purpoſe, till you come to ſet them off on the Piece you are to work; which Bevelings are always ſet off from the Inſide of the Piece, as in the *Fig*. 6. 10, 5, 7, being deſigned to go to the Timber. And keeping the Stock of the Bevel 15, to the Inſide, the Tongue 16 being fitted to the Beveling will mark out 6, 8, which will cauſe the projecting Part of ſuch

Wales to be out of Winding throughout the whole Work. This is termed Bearding the Channel-wales; which when you have done (firſt obſerving that your Pieces are exactly of a Thickneſs, and the Bearding projected from the exact Thickneſs of the Plank you deſign to work in the Wake of ſuch Wales, as 6, 7,) then ſet off the Depths from 7 to 10; and ſquare over from 10 to 9. Which Method will make the Piece exactly of a Breadth on the Beveling, or Declination of the Side. If the Ship-ſide declines much from a Perpendicular, this Method will not look well to the Eye, provided your Sight is level from the Object, or Channel-wale. Therefore to make ſuch Wales of equal perpendicular Heights, you muſt proceed as in the *Figure* 7, by making Uſe of ſuch a Square as 8, 9, placing one Limb on the Bearding 1, 2, and ſetting off the exact Depth you deſign the Piece to be. On the other Leg, the Point 4, will mark out the Breadth, or more properly the Depth of the Pieces fore and aft the Ship. Then you may either make the lower Part of the Wale parallel to 1, 2, which will be the Level as 6, 4, or parallel to 2, 3, which will be Square. But the lower Part is commonly ſet off between a Level and a Square, in ſuch a Method, as the Line 4, 5. But ſuch a Method will require more Waſte, or Wood to work on, if the Declination of the Ship's Side be conſiderable.

There is yet one Obſervation worthy of Notice in working the Channel-wales, which are crooked, called Harpings, and Following Pieces to the Harpings; ſince ſuch Pieces ought to hang neither more or leſs in their Length, on a direct Line fore and aft the Ship, than the Midſhip Pieces. But ſuch a Crookeding cannot be ſo well marked on them, by ſpringing a Line by its Elaſticity; for ſo large a Spring cannot poſſibly fall exactly true. It will therefore be more proper to put ſuch a Piece into a Poſition, that it may, after it is pointed with a Plummet, be altered from that Poſition, into ſuch a one, that, when the Sides of the Piece are made Perpendicular, will either hang or be crooked, according to what you deſign: Which is done only by canting the Piece, as 'tis called, backward and forward, according to the Hanging and Crookeding you deſign to give.

Theſe following Pieces or Harpings commonly wind or twiſt two Ways, as may be obſerved by the Lines 1, 2, 3, 4, 5, 6, 7, (*Plate* 6. *Fig.* 4,) 4, being perpendicular to the Horizon, and the other declining from the Horizon, or Perpendicular two Ways. And in ſuch Caſes you muſt have two Bevels, putting one Part, as the Stock, parallel to the Horizon, and the other Stock of the other Bevel always perpendicular to that.

The *Figure* ſhews the Nature of ſuch Bevelings in the Wake of any following Pieces; 4, being perpendicular, and where the firſt Bevel Spot ought to be taken; 1, 2, 3, being Bevel Spots afore the Middle of the Piece; and 5, 6, 7, abaft that Spot. Therefore to put this Piece out of Winding, is to make the upper Edge according to the Line *a*, *b*, which is to keep the Limb of your level Bevel 15, in *Plate* 5. *Fig.* 3, always exactly in the Line *a*, *b*.

There is ſtill another nice Point to be conſidered in the Harping, which is always round as well as the following Pieces; and altho' Wales, yet they may be bent by Fire, provided there are not Pieces at hand, which are as circular as are requiſite. But the difficulty conſiſts in taking the Bevelling; for if the Ship is placed much by the Stern, there muſt be an Allowance for that Declination of the Ship, in taking the Bevelling of the foremoſt Part of the Harping.

All Plank ought as much as poſſible to lie on a direct Plane; for in any other Poſition, the danger in bending or twiſting of them to their Work, will be greater than if they rounded on a direct regular Plane, in proportion to ſuch an irregular Twiſt.

In working up a round Buttock of a Ship, the lower Edge of the Planks will have a ſudden Sny aft, tho' the upper Edges are always lined ſtrait. So that the Planks under the Nuckle Timbers forward, and perhaps the after Ends of ſuch Planks as the Buttock; and the foremoſt Ends of the others (according to the Faſhion of the Ship) are 16 or 18 Inches broad, and the other Ends not above twelve.

All Planks under the Whale ought to lie upon direct Planes, as ſoon as they can be brought to ſuch a Poſition, and above the Wales you are to work the Breadths of all Plank by Perpendiculars and parallel Heights.

Plate V.

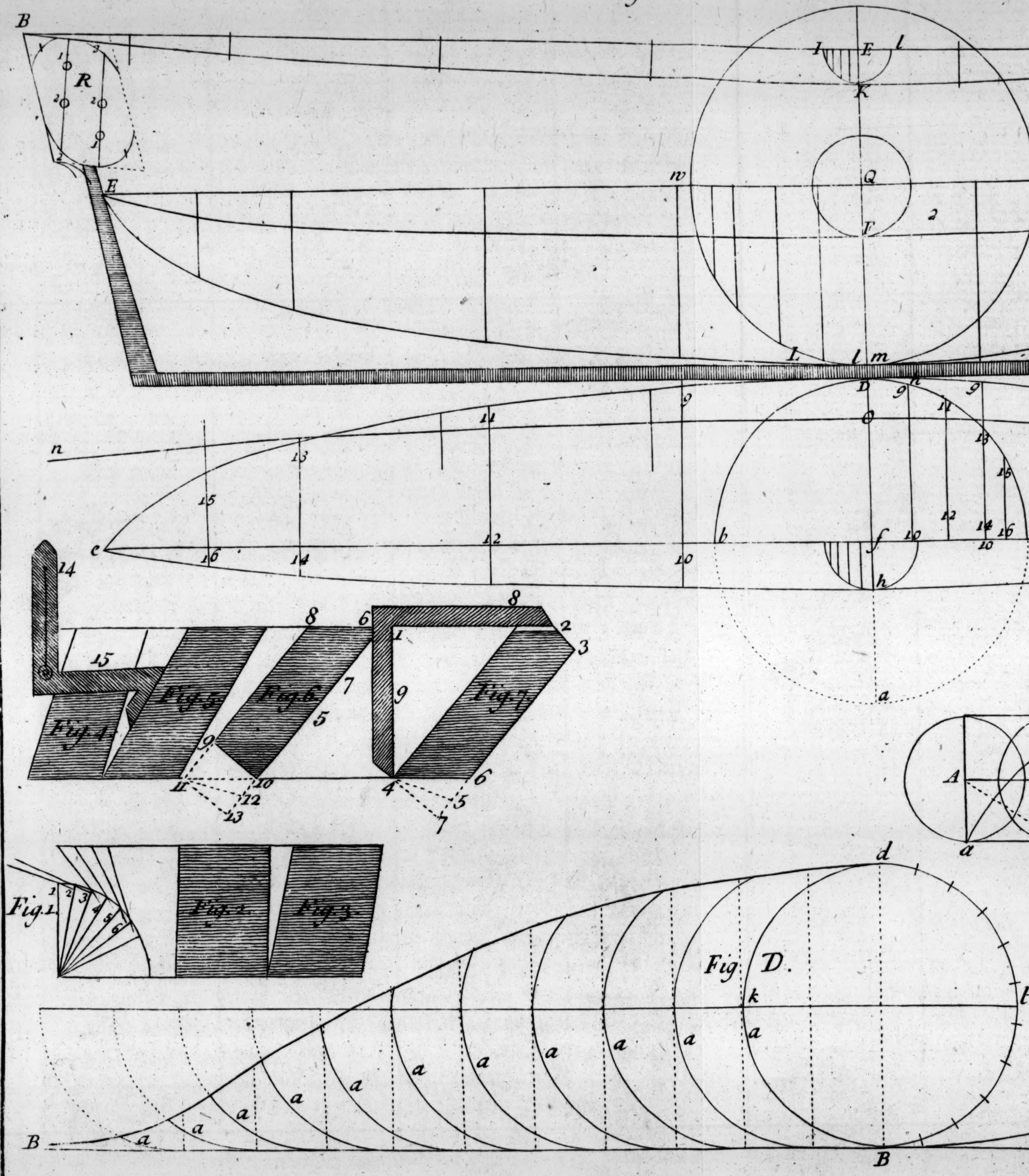


Fig. A.
B
R
E
w
Q
F
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L
l
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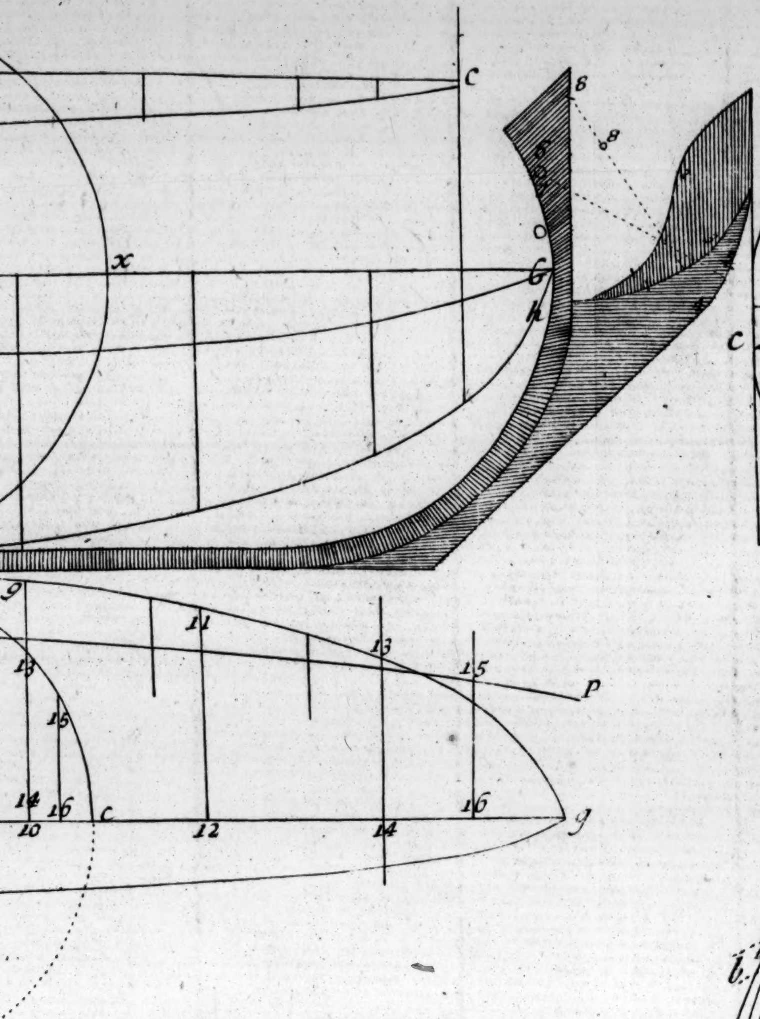
h
a
Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6.
Fig. 7.
A
a
Fig. D.
d
k
a
B
B



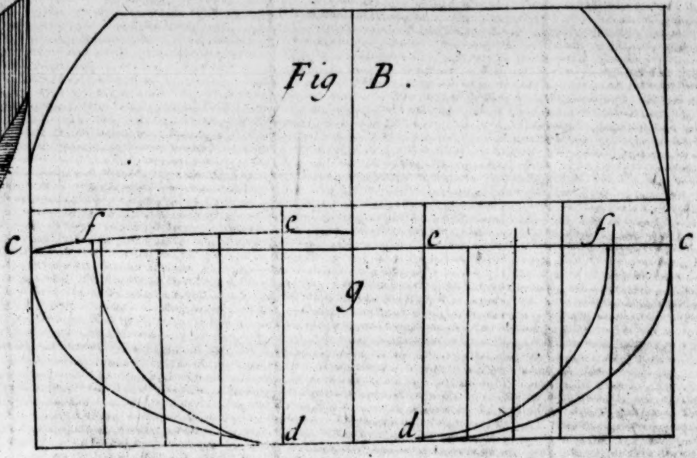


Fig B.

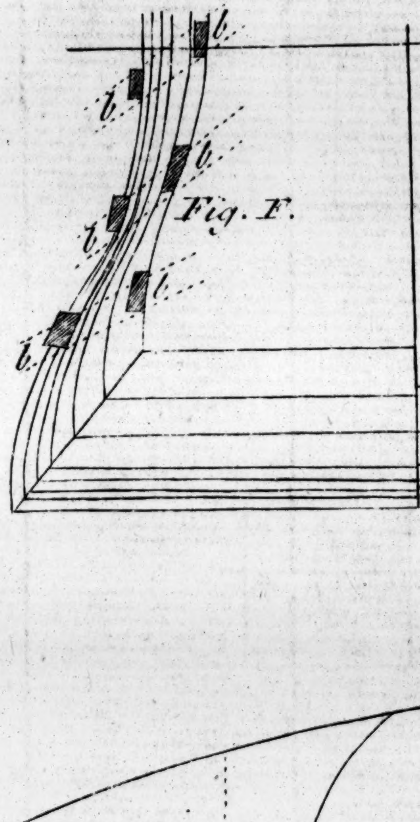


Fig. F.

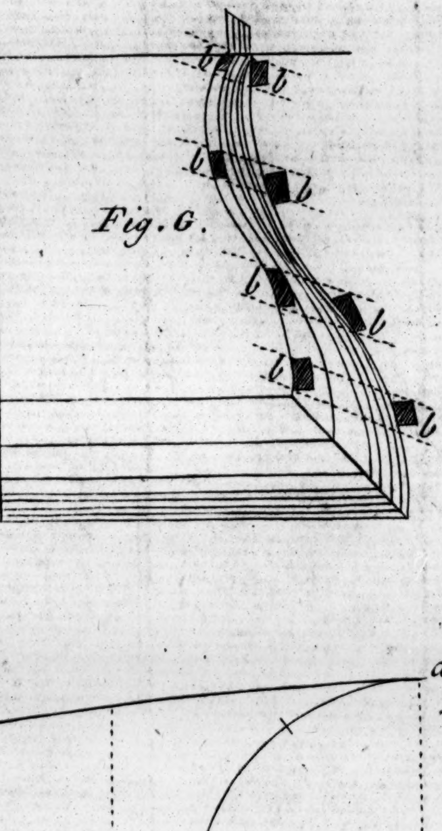
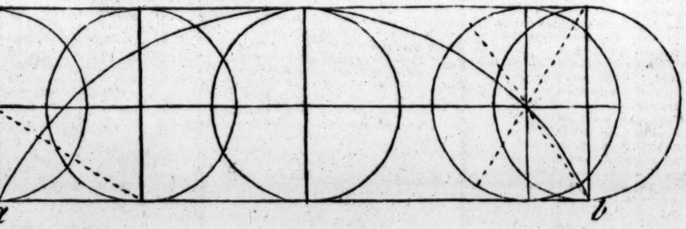


Fig. G.



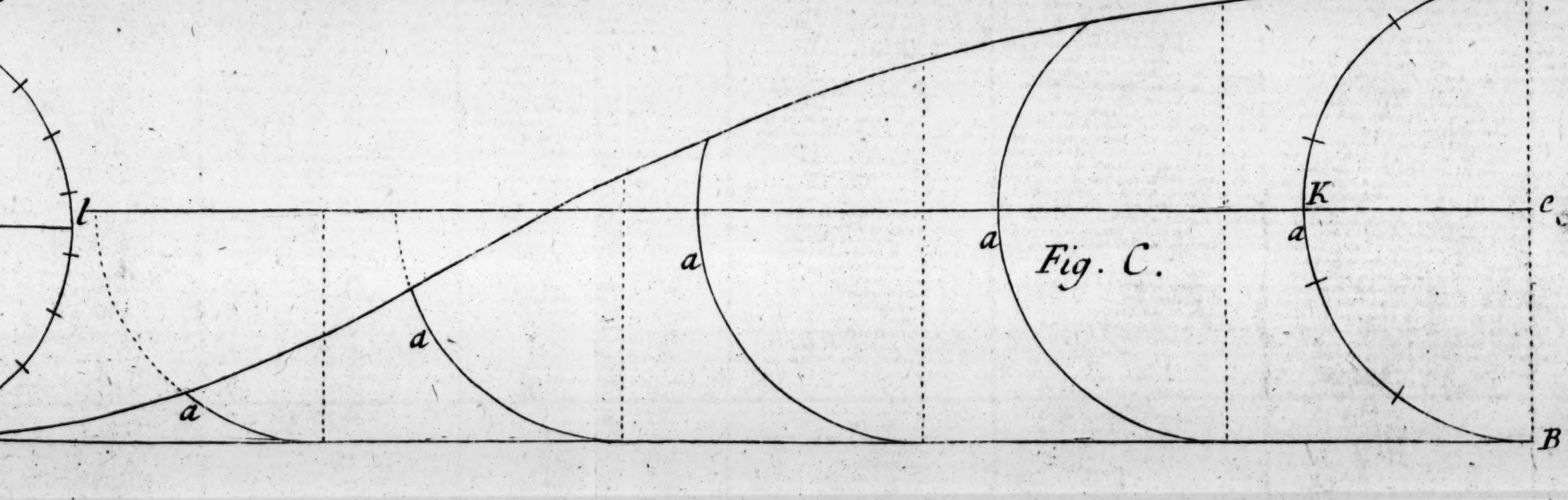


Fig. C.

Snying is obſerved to make the working of Ships Bows very difficult, and the Plank to perform the ſame very chargeable to be purchaſed. Since all the Plank, which births up any Ship's Bow, muſt be converted from principal Compaſs Timber. For tho' Plank may be eaſily bent flat-ways, yet take what Method you pleaſe, it cannot be near ſo well bent Edge-ways, becauſe of the great Diſproportion between the Breadth and Thickneſs. In ſuch Bows therefore there muſt be wrought large principal Timber, if you work according to the common Method of bringing every foremoſt Hoodings End to the Rabbit of the Stem.

CHAP. IX.

Of BEAUTY.

THIS Branch teaches to deck or adorn a Ship, or ſuch like Machine, with that Symmetry of Parts, as to render it agreeable to every Spectator; but with this Proviſo, that the Beautifying may be no Detriment to the other good Properties.

And here a very delightful Scheme preſents it ſelf, if we conſider the admirable Contrivance of Nature in the Production of Natural Bodies, formed after the moſt exact and accurate manner. From whence Obſervations may be made for laying down Rules uſeful both in this and other Arts. But it may not be amiſs further to take notice here, that there is a vaſt Difference between Bodies wholly immerſed, as Fiſh, and thoſe which carry their Bodies in two Elements, as ſome Fowls. Wherefore before the true and exact Shape of a Ship be fixed on, the Proportion ought to be truly conſidered; which cannot be better determined than from obſerving out of the vaſt Number of Ships that are in the World, which are the eaſieſt and pleaſanteſt in the Wear, and have likewiſe all other good Properties. Theſe are the Ships from whence the Lengths, Breadths, and Depths of all Shipping ſhould be derived. But as to the Shape, it ought to be taken from Art and Nature, and drawn from a Globe. Not that any Ship can be thought regular, or rather convenient, perfectly globular; for then ſhe would not anſwer the Deſign of ſuch a Machine, but move always that way which the Wind forced her, or directly from the Wind's Eye; for it is very obſervable, that although the Wind has a great Power over any Ship, as long as ſhe is at reſt, and before any Sail is ſet or ſpread upon her; yet when her Sail is managed and trim'd to it, ſhe will, by traverſing, ſail directly to Windward, which could not be, were her Length and Breadth equal; for then ſhe would move with the ſame Facility Side-ways, as End-ways, and go directly with the Impulſe of Wind. However, a Ship may, and indeed ought to be formed as near a globular Figure as can poſſibly be allowed, with reſpect to the other Conveniencies that will be requiſite in managing of her.

Plate 5. *Fig.* A, ſhews that *a*, *b*, *c*, *D*, is the Circumference of a Globe's Superficies, and *e*, *f*, *g*, *h*, a Plane drawn in Proportion, as 4 to 1; tho' all Ships do not bear ſuch a Proportion, but perhaps ſome more, and ſome leſs. However, ſuch a Figure may be drawn in any other Proportion.

Let this Plane then repreſent the extream horizontal Baſis of a Ship at her main Breadth, and alſo ſerve for the Riſing Line, to ſhew the Swing of the Body on a vertical Poſition: And this very Scheme may be made applicable to form every Part of a Ship's Body.

For let the Semicircle *f*, *c a b*, be the extream half Breadth, the Line *E*, *F*, *G*, the lower Height of the Breadth Line, and Narrowing of the Floor Line; and let the Semicircle *I*, *K*, *l*, be the Hanging of the Sheering Line; Then *B*, *K*, *C*, will be the Sheering Line, which may be made applicable to the Narrowing of the Top-timber, provided it be properly uſed. For if you deſign a Square Stern, and a broad Fore Body, then that Diſtance of Breadth the Ship is there, beſides the circular Part, ſhall be ſet off from the middle Line on the Ship's Body, as a blunt-headed Solid, by whoſe Rotation the Top-timber Line ſhall be formed. And this may ſuffice to ſhew the three tranſverſe Lines, that will ſhape any Ship's Body length-ways.

The Narrowing of the Top-timber Line is *N*, *O*, *P*, being ſimilar to *B*, *K*, *C*, the Riſing Line, which ſhews the Swing of the Body, on a vertical Poſition; *E*, *m*, *b*, the narrowing of the Floor Line being ſimilar to *E*, *F*, *G*. The Knee of the Head is alſo formed by perfect Circles, as the foremoſt round Part 4, 5, ſwept from 6, the cutting down or Sheer of the Knee

1, 3, ſwept from the Center 8; and the Back of the Lion rough 1, 2, is ſwept from 7. And after ſuch a circular Faſhion may every Rail of the Head be formed. But the Gallery is a Rhomboides, ſo that the *Figure* R, being divided into 4 Quarters, and ſubdivided again into equal Parts, draw Diagonals to thoſe Centers, and the oppoſite Quarters are to be ſet off parallel from them. The Circles *w*, *x*, *l*, mark out the Line *E*, *L*, *G*; the Circle *Q*, the Lines *E*, *F*, *G*, and *e*, *h*, *g*; and the Circle *E*, the Line *B*, *C*, *K*. For the Circles being divided into Chords, and the Planes into equal Diviſions to the Circles, as in the Circle *a*, *b*, *c*, *d*, let it be divided as 9-10 : 11-12 : : 13-14 : 15 & 16. Then ſet off the Diſtance of 9-10 on the Circle, at 9-10 on the Plane, and the Diſtance of 11, 12, in the Circle at 11, 12, on the Plane; and 13, 14, and 15, 16, accordingly. Which being reconciled, will turn thoſe Planes into regular Curves, ſuitable and applicable to form any Ship's Body Tranſverſeways.

Fig. B, ſhews the Conjugates or Ribs of a Ship. And theſe Parts may be alſo formed after the ſame Faſhion, as may be ſeen in the Quadrants *e*, *d*, *f*, and *c*, *d*, *e*; *e*, *d*, being the narrowing of the Floor; *g*, the middle Line; the Circle *d*, *f*, ſwept from the Center *e*, and that Quadrant transferr'd to the Quadrant *e*, *c*, *d*, forms the Girt of the Ship's Body below the Breadth. *c*, is the lower Height of Breadth, and the Reaſon of having two Heights is, firſt, to make a Ship carry a greater Burden by continuing the Breadth; ſecondly, to cauſe her to carry Sail, and alſo render the Top-timbers beautiful, in making the Curves both ſhorter and more gibous.

Fig. C, E and D imitates the Cycloids or Trochoids, tho' our Mathematicians lay them down as follows. Let a Wheel or Circle *A* be imagined to make one intire Revolution on a Right-line *a*, *b*, ſo that the Point of the Wheel *a*, when it comes to the Point *b*, will deſcribe a Curve equal to the Periphery of the Wheel that acts upon ſuch a Line. From hence 'tis plain, that by Means of a Cycloid, a Right-line may moſt eaſily be found equal to any Arch of a Circle, or its whole Circumference; and conſequently the Quadrature of the Circle may Geometrically be had, if the Cycloid be a Geometrical Curve, which the Mathematicians deny. However, the *Linea* *celerrimi deſcenſus*, or the Curve which any heavy Body would deſcribe, ſuppoſing it to deſcend with the greateſt Swiftneſs imaginable, is the Arch of a Cycloid.

In *Fig*. C and D, may be ſeen, that by equally deſcribing the Arches *a*'s, extended in as many Parts as you pleaſe, ſo that the Proportion of Length to the Breadth may be according to any Dimenſion; then by dividing the Circles *d*, *K*, *e*, *B*, into as many Parts as there are Arches, and by taking the Diſtance of every equal Part on the Circle, from the Line *B*, *B*, and ſetting it off on the Arch's *a*'s, you will deſcribe the Curve *B*, *d*. And after ſuch a Manner may every circular Part of any Ship be laid down and demonſtrated. But then it muſt be obſerved, ſuch Bodies will not be of the blunteſt ſort, or ſuch as are perfectly Parallelopipedons, with only the Corners cut off. And ſince ſuch Curves are not Mathematical, they may better ſuit Shipwrights, that have ſuch an Averſion to the compoſing the Bodies of any Ships or Veſſels by ſuch perplexed Demonſtrations as they ſuppoſe the Mathematical Curves to be.

Such Figures as are here laid down, only ſhew the Method for round or pink-ſterned Ships; tho' in deſcribing the Narrowing of the Top-timber Line it may be taken for a ſquare or broad-ſterned Ship. But without ſome other Conſiderations, broad ſterned Ships will be found unnatural, and only regarded for Accommodation above Water. And if ſuch Veſſels were conſidered in the Manner as they ought, they would be produced from ſuch a Faſhion; firſt, by drawing the Curve to a Period, and then biſecting it at the aſſigned Length. And the Conveniency in ſuch Sterns is to have Breadth to make Windows, to enlighten the Great Cabin, and other Apartments. But ſuch Sterns ought to be very well ſecured with Timbers, Tranſoms, and Knees. The Beauty conſiſts in the due ranging and exact curving the Rails and Brackets, and making the Galleries ſuitable to the Sterns, as may be ſeen in the *Figures* A, B, and C, D. *Plate* 6.

Fig. A repreſents the Stern and Gallery of a Sixth Rate: The Rails are marked *a*, and Brackets *b*, there being one Tire of Lights to enlighten the Great Cabin. Above and below that Light is ſhadowed Freez. The Gallery B, ſuits the Stern in Beanty and Uniformity, tho' the Gallery makes almoſt a

Right-Angle with the Flat of the Stern, when fixed on the Ship's Side. The Extreams of the Stern are a perfect Circle, and ſwept from the Center *K*, and will appear more beautiful than any other Curve whatſoever. For 'tis not to be imagined that a perfect Circle, ſwept on the Flat, will appear ſo to the Eye, looking on the Rake of the Stern of any Ship.

Fig. C, repreſents the Stern of a three Deck Ship, which is the biggeſt Size, the Extreams of which are very different from a Circle, and therefore cannot be ſo performed. It muſt therefore be ſwept by 3 Sweeps, 1, 2, and 3, the Rails *c*, are curved by diminiſhing the Line *a*, *b*, which ſhews that Ships Decks ſhould increaſe their Heights upwards in the Middle, being the Place of the principal Acting in any Ship, for two Reaſons. For firſt it vents the Water out of the Scuppers, and then it keeps the Deck down at the Ship's Side, cauſing a Ship to be ſnug. But the Beauty of it conſiſts in this, that the Surface of the Water appearing to the Eye perfectly ſtrait, and the Sky circular, by making ſuch Rails round upwards, they the more nearly imitate Nature, and ſeem to join in a due Order and Decorum.

The Gallery Rails *c*'s are deſcribed by holding a ſtrait Ruler at the Height of your Stern Rail, in the middle of the Stern, and alſo at the Extreams, and ſo drawing a ſtrait Line for each Rail of the Gallery. But then the Round of the Stern ought to anſwer the Quickening of the Sheer of the Side, which is a Method altogether impracticable, but at one Place; ſince all the Rails of the Gallery ought to lie parallel, and the Stern Rails variouſly rounding.

d, is the upper Edge of the Wing Tranſom, and the Height of the lower Part of the Gun-room Port; as alſo that Place where generally the extream Breadth of the Ship lies abaft. 4, 4, is the Sweep below the Breadth, and 5, 5, the Sweep above the Breadth.

The Stern of a Ship is faſhioned like a Rhombus, raking aftward, making the Ship commodius and beautiful, as Length is always allowed to do; beſides it anſwers the Rake of the Poſt, which ought to rake for the Conveniency of Planking. *Fig.* D, is a Raking Arch, ſwept from two Centers, 1, and 2, bounded by a Rhombus *a*, *b*, *d*, *c*, which may be called the Top of a Gallery, and ſuiting the Rake of the Stern; and by letting fall the Perpendicular *e*, *f*, from the middle of the Line *a*, *b*, it deſcribes a Line wherein the Centers are found, 1, and 2.

Fig. E, is of the ſame Nature, only deſcribed after another Manner, which is to divide the Limbs *b*, *f*, and *b*, *c*, into equal Parts, and by drawing Diagonal Lines, the Arch *f*, *c*, paſſing through their Interſections; then ſetting off equal and parallel Diſtances of that Arch from the middle Line *g*, *f*, the other way it deſcribes the Arch *f*, *h*; it may alſo be ſwept from the Centers 1, 2, 3, 4.

Fig. F and G, are Raking Bells repreſenting the Top of a Gallery, and may be deſcribed as the other Arches are, only obſerving the Points of Inflexion *a*, and *b*. From ſuch Methods may any faſhioned Gallery be formed.

Fig. 1, 2, 3, are the Rails of the Stern diminiſhing upwards. It ought alſo to be obſerved, that all Rails which are placed on the Stern of a Ship, ſhould round more than what is allowed to appear in ſight, as much as the Difference is between the Rake of the Stern and a perpendicular Line, conſidered according to the Round of the Rail that you allow aftward. As in *Fig.* 5. you may obſerve, that the Line *e*, *b*, is a Parallel drawn from the Stern Side-timber, and the Line *a*, *b*, perpendicular to it. Therefore ſince all Stern Rails project perpendicular from the Stern, the Difference of the Rounding ſhould be according to the Difference between the parallel and perpendicular Lines in the rounding of every Rail.

The other Figures are the Faſhion of Stern Rails imboſſed, according to ſome general Faſhions; and whoever is deſirous to be more curious, may conſult the Works of our beſt Architects, who have written very large on that Subject.

The Head of the Ship ſerves for little elſe than Ornament (for ſeveral Ships have no Heads) ſince its chiefeſt Conveniency is to tack the Weather Clew of the Fore-ſail forward, to gammon the Bowſprit, to water the Proviſion, and for Houſes of Eaſe. As to the tacking the Fore-ſail forward, it has a principal Uſe to trim the Sail to the Wind, that the Lee Leetch may not bag, and oppoſe the Motion of the Ship. And then it may be conſidered, whether ſuch over ſhort Heads are proper, from the Diſtance there is between the Main-maſt and the Cheſſe-tree, that tacks the Main-ſail forward.

Plate VI.

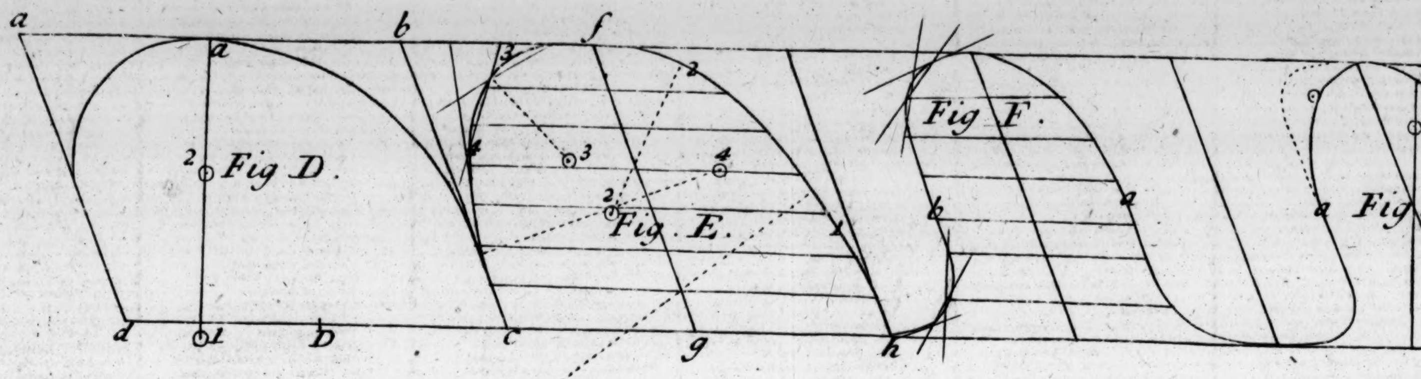
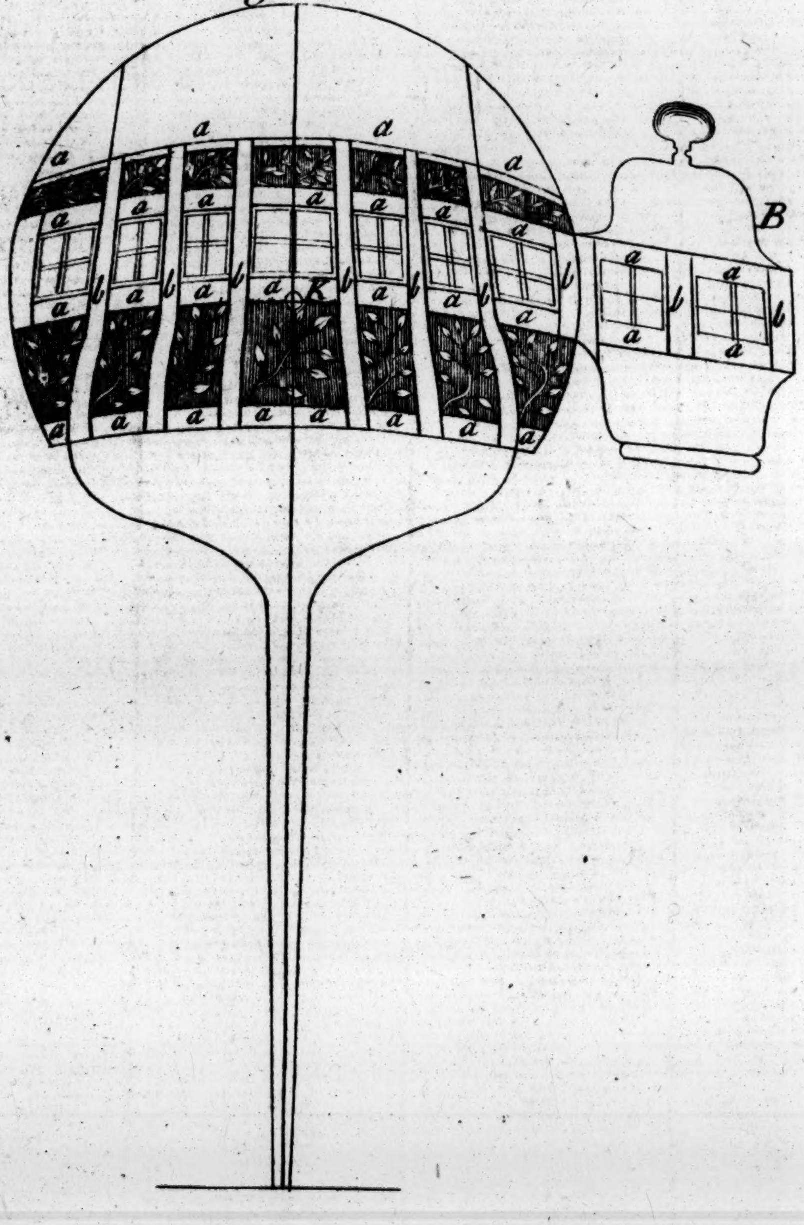
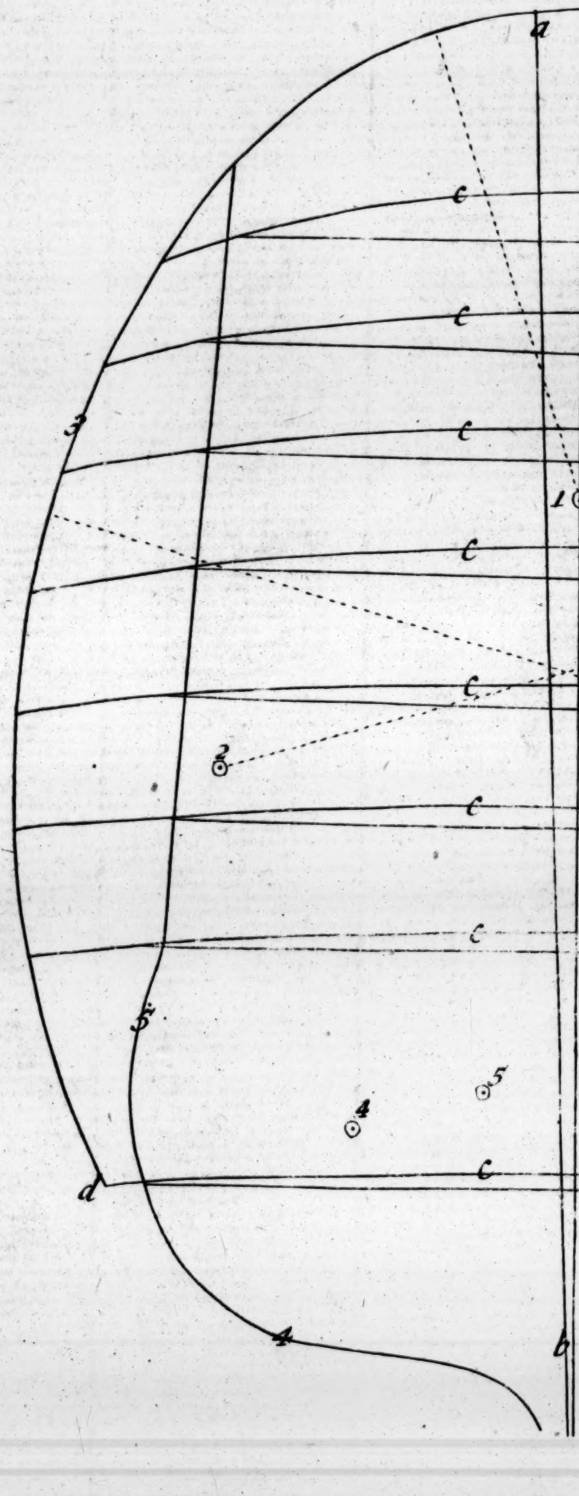


Fig A.





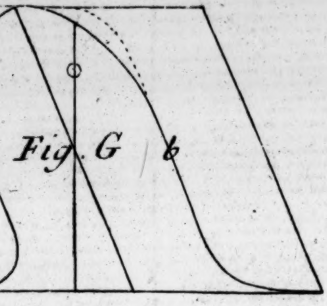


Fig. G

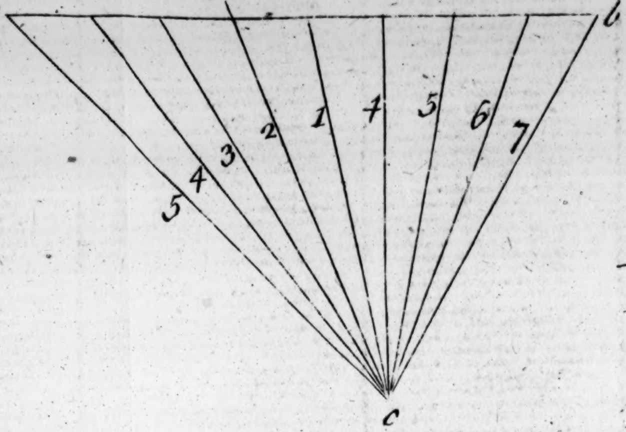
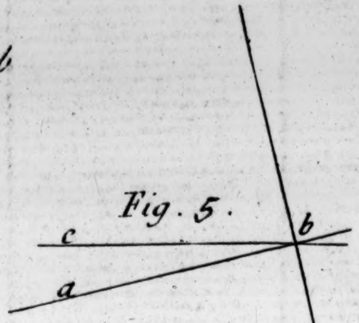
Fig. 4.


Fig. 5.


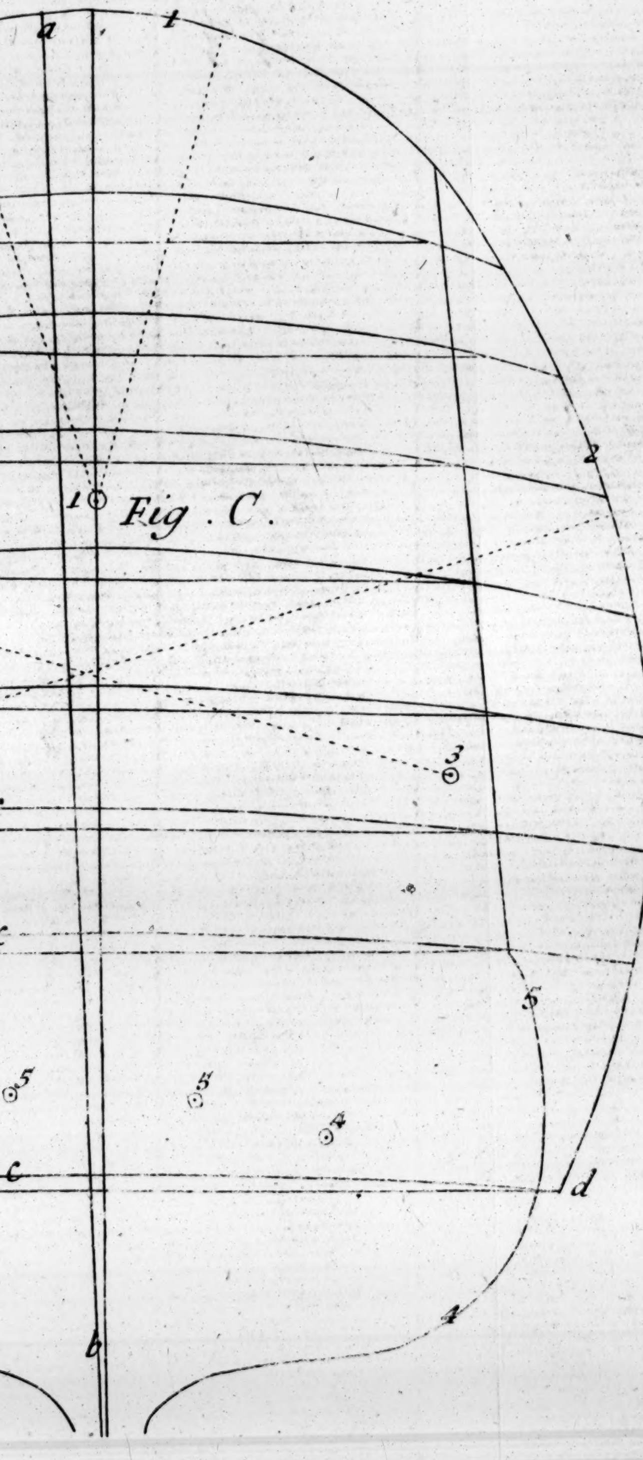
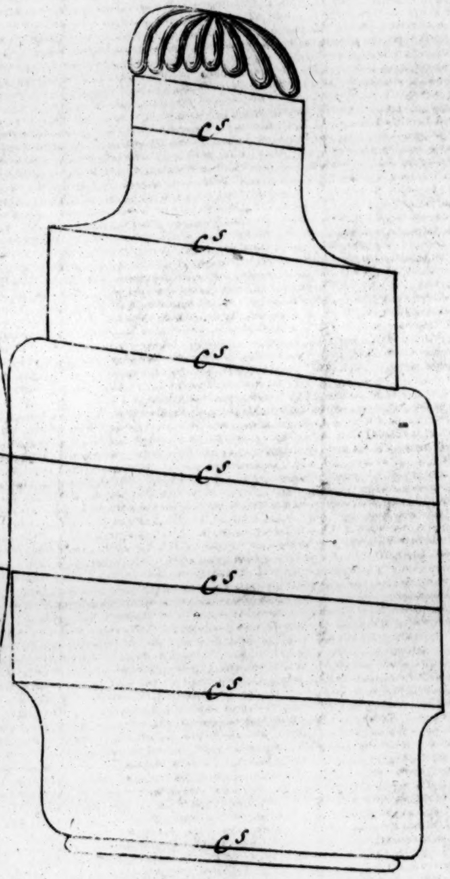


Fig. C.



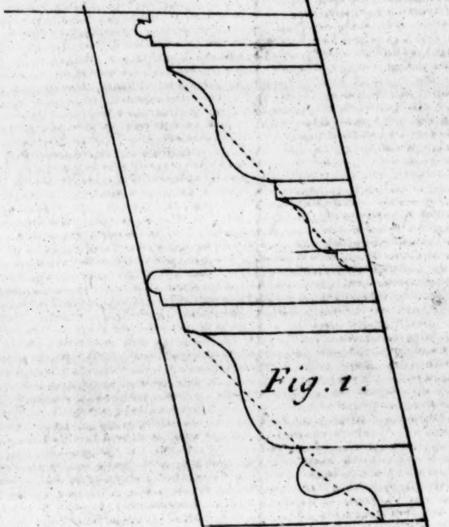


Fig. 1.

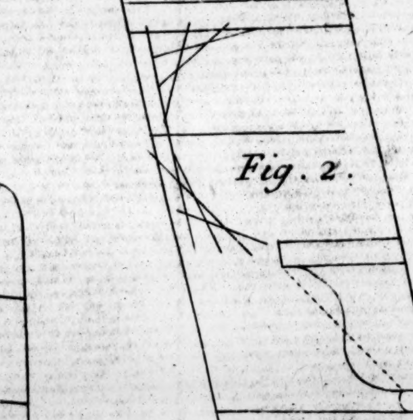


Fig. 2.

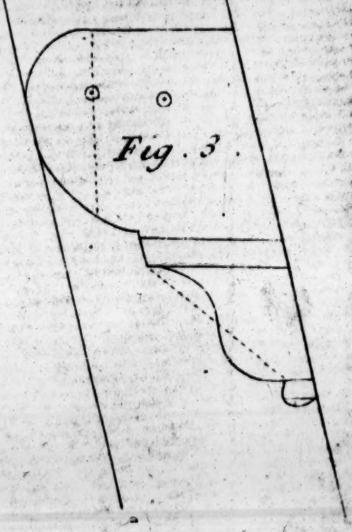


Fig. 3.

The Beauty of this Part is more admired, and its Deformities ſooner diſcovered than any other Part. For the Heads of all Creatures are moſt obſerved by all competent Judges; and the Symmetry of the whole depends much on the Proportion or Diſproportion it bears to the Head. For to ſee a Head with all its Parts well and neatly formed, and a due Proportion and Harmony between them, ſtrikes with Admiration the Eye of the Beholder. From ſuch Obſervations the Head of any Ship may be faſhioned, ſo as to make it beautiful, that is, to form it perfectly circular, if the Dimenſions will bear it; but if not, by Ellipſis's or ſpiral Spaces.

Plate 7. *Fig.* A, repreſents the Head of a Ship of 250 Tuns: *a*, is the Stem; *c*, the fore Foot, or where the Stem and Keel are ſcarfed; the Keel at the foremoſt End is left big enough to bear the Stem's being let into it, beſides a But left for the Gripe to join to. *b*, is the Gripe; *b*, the Knee of the Head, or principal Piece, faſtened to the Stem, with Bolts ſuitable for that Purpoſe, the Knee being ſcantled to ſuit the Stem as 'tis join'd to it. But the foremoſt part of the Knee is barded away as ſharp as it can conveniently be, termed a Cut-water. The upper Part of the Knee is generally two-thirds at the Lion's Breaſt of what it is at the biggeſt Part, and wrought taper. *D*, are the Cheeks, being Knees bolted through the Knee of the Head, and to the Ship to ſteddy the Knee.

In hewing of Cheeks this Method ought to be obſerved, to make a Mould to the cutting down of the Knee of the Head *D*, *K*, *L*, and prolong that Mould parallel with the Rounding or Sheer of the Harping, as far as the Cheeks are to be placed; then inſtead of hewing the Cheeks as cuſtomary, by putting them on their Ends, and hewing them perpendicular from the Breech, hew them by the hanging of ſuch a Mould, which will give the true hanging of the Cheek at the Stem or Middle of the Cheek; *f*, are the Rails of the Head, the uppermoſt being truly circular, as are likewiſe all the other. Altho' the Notion among Shipwrights is, that ſuch Rails cannot, nor ought to be truly circular; which I only take to be an Amuſement to the young Practioner, as in many other Caſes, it being the Buſineſs of moſt Shipwrights to ſuppreſs and keep back the grand Principles of the Art from young Beginners. Such Rails ought alſo to diminiſh forward. An Inch in twelve Feet will be ſufficient, meaſured on the Circle of each reſpective Rail.

The upper Side of the upper Rail in the Middle ought to be level, for the Conveniency of Mens ſtanding on them, and that the Gratings may alſo lie level, and out of winding with the Rails. The after Part of the Rail ought to bevel to the Cat-head, and bolted to the ſame, which is marked *I* in the Figure. The foremoſt Part of the Rail, if you ſquare it as cuſtomary, will want Wood on the out-ſide, when in it's place; and the Reaſon is from its ſpreading a great deal more Abaft than Afore, as may be ſeen in Figure C. Let *a*, *e*, repreſent the middle Line; *e*, *c*, the ſpreading of the Rails at the After End, and *a*, *D*, the ſpreading at the foremoſt End; *c*, *f*, being parallel to the middle Line; ſo that the Want in the beveling of the Rail at the foremoſt End is, as the Line 3, 4, to the Line 1, 2; which is chiefly cauſed by the Circle of the Rail. For that Part of the Rail which lies level and perpendicular to the Horizon, will always be ſo, let the ſpreading of the Rail be what it will; I mean the middle Part of the Rail. *g*, *Fig.* A are Brackets, and Timbers on the inſide of the Brackets, the Timbers being the principal Security to all the Uſes of the Head, as the Jack-piece in particular; *e*, is the Lyon, (ſome Ships have the Figure of a Horſe, *&c.*); *n*, the Trail which is curved, tho' it would be better if otherwiſe, ſince the Bolts that faſten the Timbers, Kelſons, and Standers, go through the Trail; and ſometimes for want of proper care, ſuch Bolts lie bare, which conſequently muſt be very prejudicial.

I, is the Cat-head, where two or three Shivers are put, to make a Purchaſe to hoiſt the Anchor out of the Water, after the Cable has brought it to the Hawſe-hole. *M*, is a Supporter to the Cat-head.

Fig. B. repreſents the Head of a Ship of 1000 Tuns, the upper Rail *a*, being curved by the Method of a Wheel or Circle. However the Center 2, ſweeps the middle Part, and 3, 4, the other two Parts, only forward the Curve is reverſed; 5, ſweeps that which makes the Top of the Crown, tho' ſometimes the upper Rail terminates as the Arch 15. 10, ſweeps the Poll of the Lyon; 10, & 11, the aft Part of the Locks; 4, the Breaſt, 12, the Back. The other Parts of the Lyon are formed ſtreight before

Plate VII.

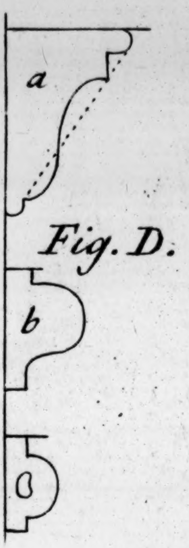


Fig. D.

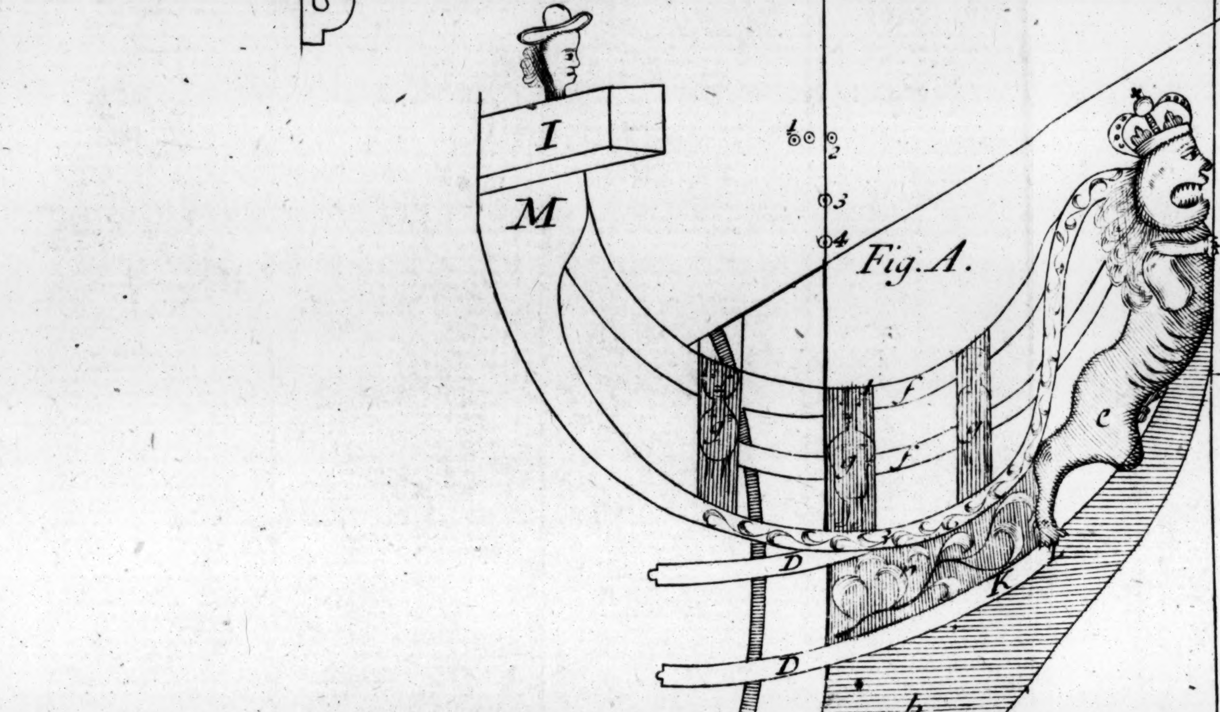
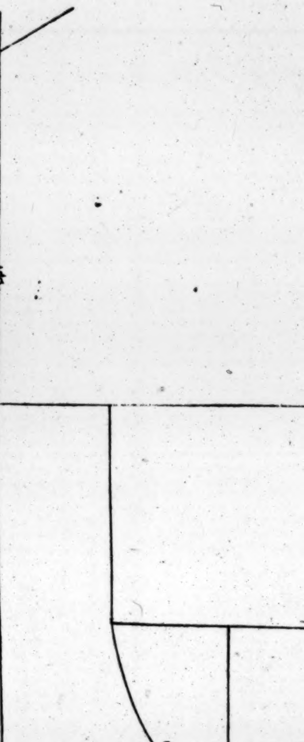


Fig. A.



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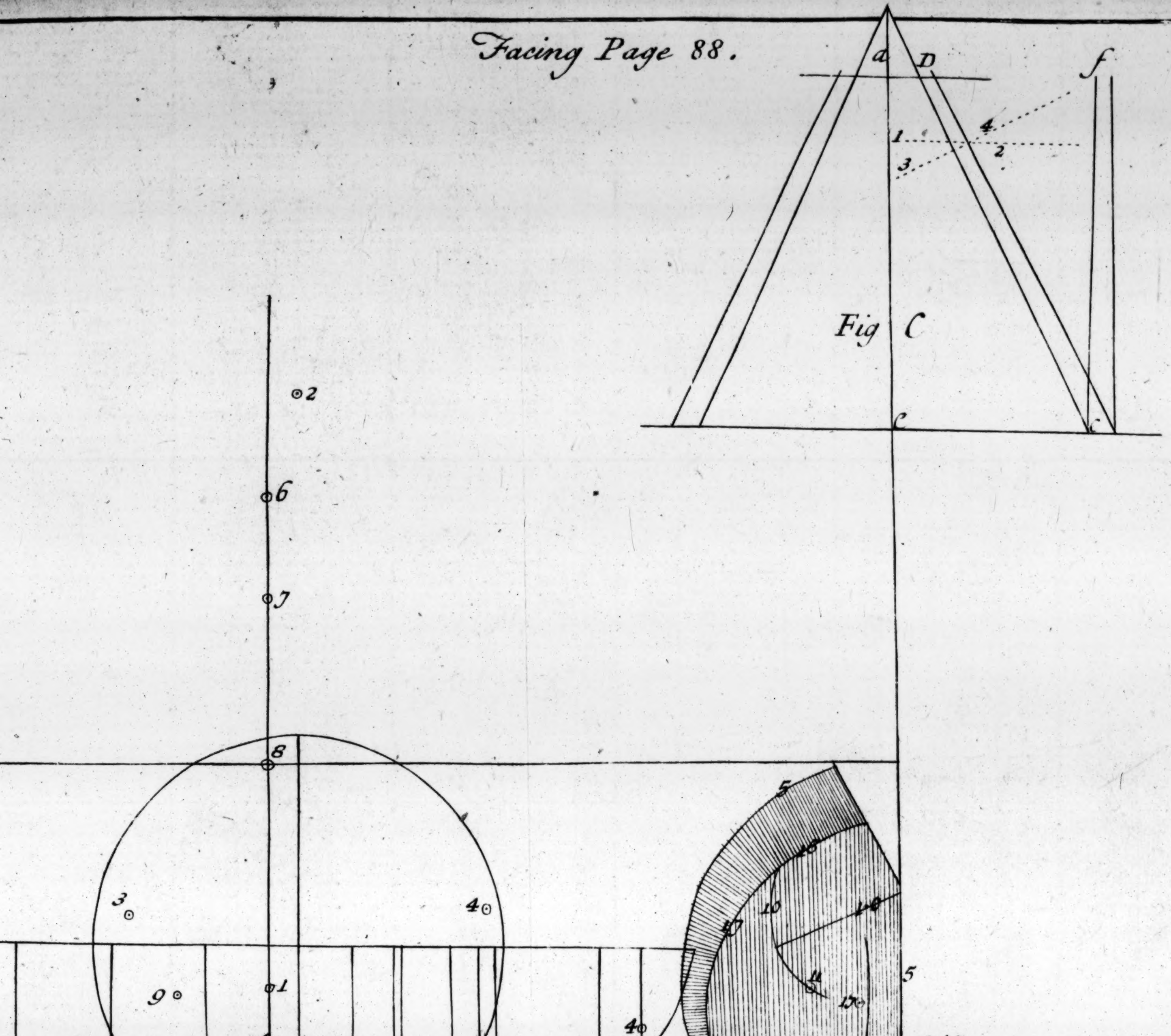

before it is carved. And after the ſame manner may every part of a Lyon be rough ſhaped. 6, ſweeps the middle Rail *b* ; 7, the lower Rail *c* ; and 9, the Raking, or lower Part of the Supporter, anſwering the lower Rail. 8, ſweeps the upper part of the Lace, to which the upper Cheek is faſtned. 1, ſweeps the cutting down of the Knee, and 13, the foremoſt part of the Knee. After ſuch an intelligible manner may every part of any Head be demonſtrated, without ſo many confuſed and perplexed Methods as are cuſtomary. *a*, *b*, *c*, *Fig*. D. is the Shape of imboſſing the Rails ; *a*, the uppermoſt ; *b*, the middle, and *c*, the loweſt Rail.

To make every thing, and the Uſes in a Ship as proper and commodious as poſſible, has been the Aim of ſeveral, as well as to beautify. For a Ship conſiſts of divers Apartments, which may alſo be termed Stories, as well as in Houſe-building, or other Fabrics; only what is called Floors in one, are Decks and Platforms in the other.

Many copious Treatiſes have been written by ſeveral Architects concerning Rules and Methods for contriving divers ſorts of Stairs in Houſe-building ; but I have met with very few that have attempted any thing of this nature for Ship-work. I ſhall therefore endeavour to give ſome plain Directions for building Stairs and Ladders for that Uſe. Indeed the Conveniency in this Branch is very different as well as in other Parts of Ship-building, ſince Fancy has been always our principal Guide.

Stairs being much more chargeable than Ladders, are not placed on board every Ship, becauſe they are chiefly for Ornament, and if well performed, they add mightily to its Beauty. However, Frugality being the common Maxim in public Affairs, in lieu of ſuch Stairs moſt Ships (ſmall ones eſpecially) have only Ladders. I ſhall proceed nevertheleſs to explain the Nature of ſuch Stairs, with only obſerving, that the Ladders are not like common Ladders, but have Side-pieces near 9 Inches broad, and ſtand at a certain Angle, according to the Diſtance between Beam and Beam. The Sides are alſo bending by regular Curves, as may be ſeen in *Plate* 8. *Fig*. P. The Steps are alſo rounding, as thoſe of the Stairs, but have no Riſes or Stiles, and are alſo to be moved more commodiouſly than Stairs.

Plate 8. Figure A, is a Pair of winding Stairs, having a Nuel in the Center, and a Side or String for the Circumference. The Portal, or clear of the Scuttle, *A*, *B*, *C*, *D*, being pointed down on the lower Plane, where the Stairs ſtand, and a Right Square being made as in the Figure, with a Pair of Compaſſes or other Inſtrument for that Purpoſe, deſcribe the Arch *A*, *D*, placing one Point of the Inſtrument in *C*; and draw a ſtrait Line *A*, *F*, *D*; Then obſerving the perpendicular Height between Decks, divide that Number into as many equal Parts as you pleaſe, for the Complement of Steps; taking notice that 10 or 11 Inches ought to be the greateſt Diſtance between Step and Step. Then divide the Arch of the Circle *A*,*D*, into as many Diviſions as you intend to have Steps, as *a*, *b*, *c*, *d*, *e*, *f*, and ſweeping the Arch *K*, *L*, from the ſame Center, divide it into the ſame number of equal Parts, as you did the Arch *A*, *D*; firſt obſerving to ſet off the Round of the lower Step from the Line *C*, *D*, to *L*, ſo that the firſt Riſe be under the upper Plane. Then with an Ellipſis or Spiral Mould, as *a*, *D*, *B*, in Figure C, mark out all the Steps and Riſes, by running the Mould backward and forward. Then proceed to find the extream Length of the Side. And in order thereto, take the Perpendicular Height from the upper Edge of one Deck's Plank to the upper Edge of the other, and ſet it off from *D*, to *G*, and from *C*, to *H*. Prolong the Bigneſs of the Scuttle to *G*, *H*; then draw the Diagonal Line *C*,*G*, which is the extream Length of the String or Side. Then Dividing the Line *A*, *D*, into any Number of equal Parts, as the prick'd Lines, being perpendicular from *A*, *D*; divide alſo the Line *C*, *G*, into as many equal Parts, and draw perpendicular Lines, as in the other Part. Transfer the Heigths of the Sweep *A*, *D*, to *C*, *G*; and find a Radius to ſweep *C*, *m*, *G*, accordingly; which is the true Rounding of the String or Side in the extream Length.

Fig. B. ſhews the Method of conſtructing another ſort of Stairs, called by Shipwrights Flying or Bell Stairs, becauſe they ſomewhat reſemble the Figure of a Bell, which having 2 Sides, the Work is quite different from the other, tho' in the Beginning ſomething of the ſame nature.

Having pointed down the Portal on the lower Plane *A*, *P*, *O*, *Q*, and made a right Square, prolong the Line *O*, *Q*, to *R*, *B*, and draw the Lines *P*, *R*; *A*, *B*, which will give the ſpreading of the Sides.

Sides: Deſcribe the Circle *A*, *B*, *a*, on the middle of the Line *A*, *B*, and transfer that Circle into the Sweep *A*, *C*, *B*; obſerving that the Sweep neither interſect the Line *A*, *O*, nor be within it. Then ſet off the Rounding of the lower Step from *ſ*, to *H*. The exact Rounding of ſuch a String or Step, was never, as I could hear, juſtly aſſigned; but the lower Step's Rounding would be moſt ſuitable, if the ſtrait Lines *A*, *B*; *R*, *P*, were perpendicular, or made a Right Angle at the Place of Contact with the Sweep of the lower Step, or at *B*, *R*. Sweep the Arch *R*, *H*, *B*, which is the Rounding of the lower Step; the other Side *P*, *R*, muſt be equal to *A*, *B*, in every reſpect. In the next Place divide the Number of Steps as before mention'd, keeping to the ſame Height from Step to Step, after you have made equal Diviſions on the Lines *A*, *B*; *P*, *R*; *G*, *H*, and ſwept every Step out from each reſpective Center in the middle Line *G*, *H*, prolonged; which compleats the Work as to the firſt Ground Plane. The String is prolonged according to the Method preſcribed in the Winding Stairs, only obſerving inſtead of taking the Clear of the Scuttle, to take the Diſtance of ſpreading from *Q*, to *R*; or *O*, to *B*; and the Height between Decks, and draw a Diagonal Line. The String or Side is alſo ſet off according to that aforementioned. But obſerve that the End Balliſters *a*, and *b*, ought to ſtand perpendicular from the Sides and Steps, and that the Diviſions for the Steps in the Figure prolonged, are to be obſerved no otherwiſe than for Shew.

Fig. O. ſhews Stairs that partake of a double Property, where you may obſerve two Strings one within another, as *a k*, and *h*, *g*, not much differing from the winding Stairs, only in the Room of a Nuel there is almoſt a twiſted String, but is wrought by the ſame Rule as the other, with this difference, that at the lower End of the longer String the Curve is reverted, as you may obſerve by *b*, *e*, *k*, which in ſome meaſure imitates the Bell Stairs. The Side *a*, *b*, is ſwept from the Center *d*; and the Center *g*, ſweeps out the Side *h*, *g*; and in dividing the Steps, you make an equal Number of Diviſions on both Sides, *a*, *l*, *k*, and *h*, *g*, as alſo in the middle Curve 1, 2, 3, 4, 5, 6, & 7. The Striking out the Curving of the Steps is done with an Ellipſis, or ſpiral Mould, as in the winding Stairs. The Nature of prolonging them is done after the ſame manner as in Figure K.

Figure D, ſhews the Method of Twiſting or Winding the Strings in all ſuch Stairs, as may be more fully conſidered, by cutting a Cylinder at Oblique Angles. For if the Fig. F, was a Cylinder, and put upon its Baſe *a*, or *b*, being perpendicular to the other Surface of the Cylinder, and then cut by any of the Lines 7,1; 7,2; 7,3; 7,4; 7,5; or 7,6; it would produce Variety of Curves. But that's not to our preſent Purpoſe, though ſuch Curves would be the moſt natural for the Strings of ſuch Stairs.

But what is here deſign'd to be mention'd, is a Method to place ſuch Strings, to make every Riſe perpendicular from the Baſe, which is no other than to imagine, that ſuch a Cylinder was to be cut by any of the Slope Lines mention'd, and to divide after ſuch a manner, that the Top and Bottom were to be taken away, leaving only behind the Breadth of ſuch a String, or 9 Inches, and that Part muſt then continue in the ſame Poſition it was before the cutting of it, as in the Figure D. Let the Curves 4, 1, and 3, 5, be imagin'd to be ſuch Curves as would be produced by cutting a Cylinder at ſome certain Angle, as was mentioned in Figure F; and the Figure D, raiſed upon its End *a*, *b*, *c*, *d*, till 1, 5, and 4, 3, are perpendicular to the Horizon; it would then be the ſame Shape and Poſition as any Cylinder that was ſimilar and cut as aforeſaid.

Therefore if the Parallelopipedon *a*, *b*, *c*, *d*, was Timber provided to form a Side or String for a Pair of Stairs, and to be moulded by ſuch a Curve as 4, 2, 1, then ſtrike the ſtrait Line 1,5,4,3, and plummet that Line down at the Ends of your Piece, making the Line *a*, *c*, and ſuch another at the other End; then cant the Piece, and mark a Line on the other Side, parallel and perpendicular to 1, 5, 4, 3, then take the Beveling of the Angle the String ſtands at, or the Diagonal Lines, as already mention'd, and ſet them off from 4, to 3; and with the ſame Mould that marked the Curve 4, 2, 1, mark ſuch another on the other ſide, by moving down the Mould in the ſtrait Line 1, 5, 4, 3, which will interſect the former at 2, which middle Part will be exactly perpendicular to the Horizon, when the Piece is hew'd or ſaw'd.

Figure G, ſhews how a Cylinder Stair-caſe may be equally divided, to make all the Steps of an equal Breadth. *A*, is a Nuel in the Middle, which is round; though 'tis very commodious, in working up ſuch Stairs aboard a Ship, to twiſt the Nuel, that

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Plate VIII.

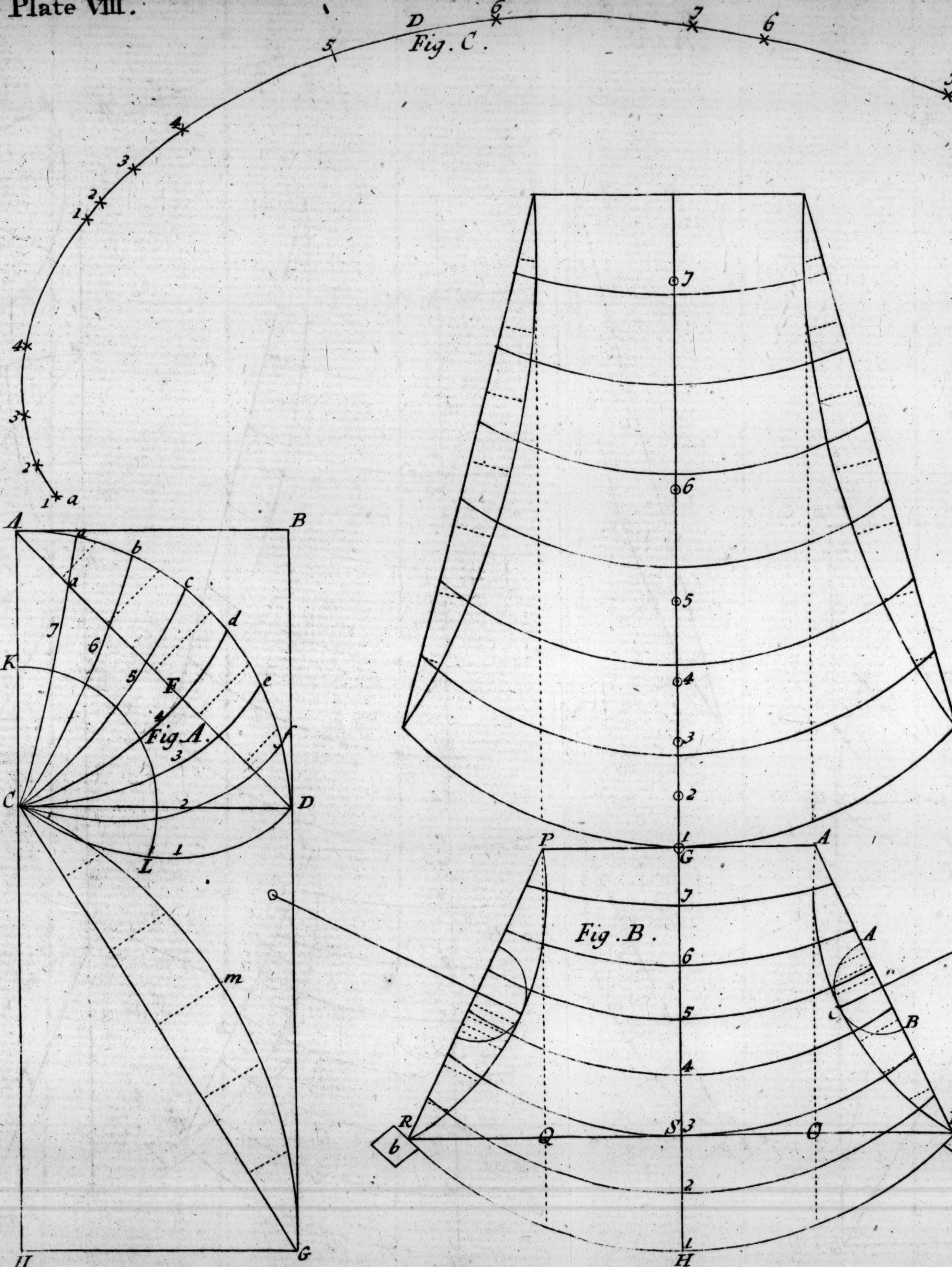
Fig. C.
D
1 2 3 4 5 6 7 6 5
4 3 2 1 a
Fig. A.
A B C D E F G H K L m
a b c d e f
1 2 3 4 5 6 7
Fig. B.
P A G R Q S O H b A B
1 2 3 4 5 6 7
1 2 3 4 5 6 7

J
B
B
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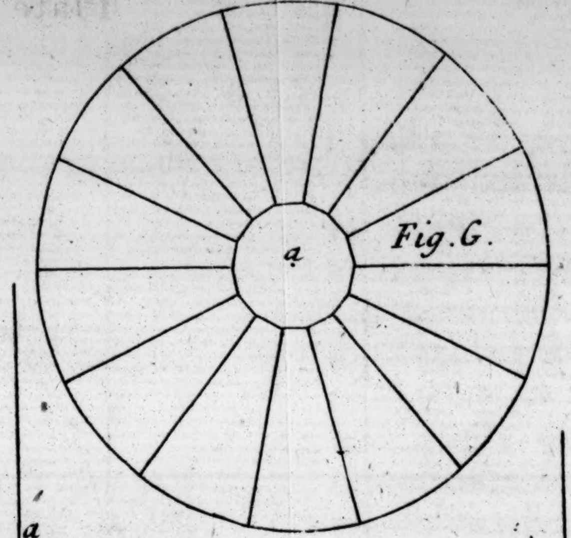
g 2


a
Fig. G.

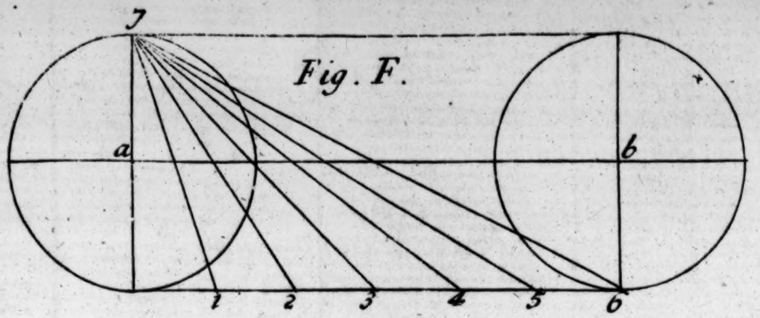

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Fig. F.
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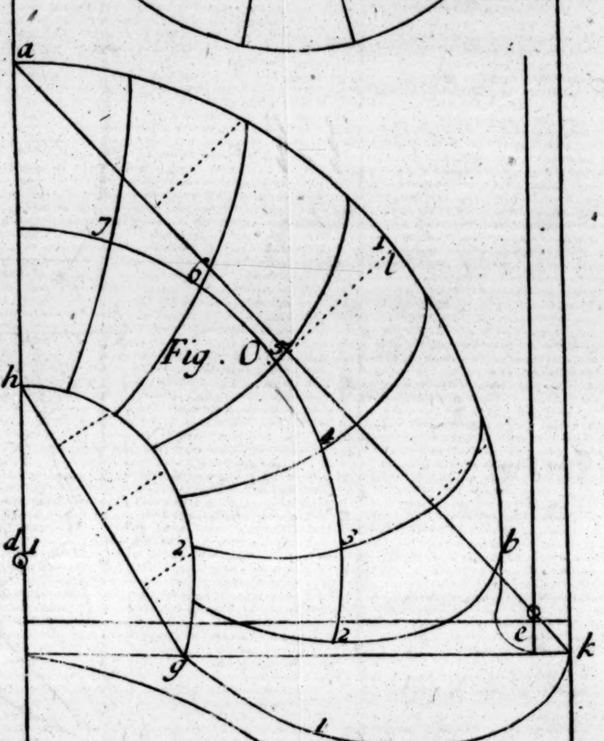
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Fig. K
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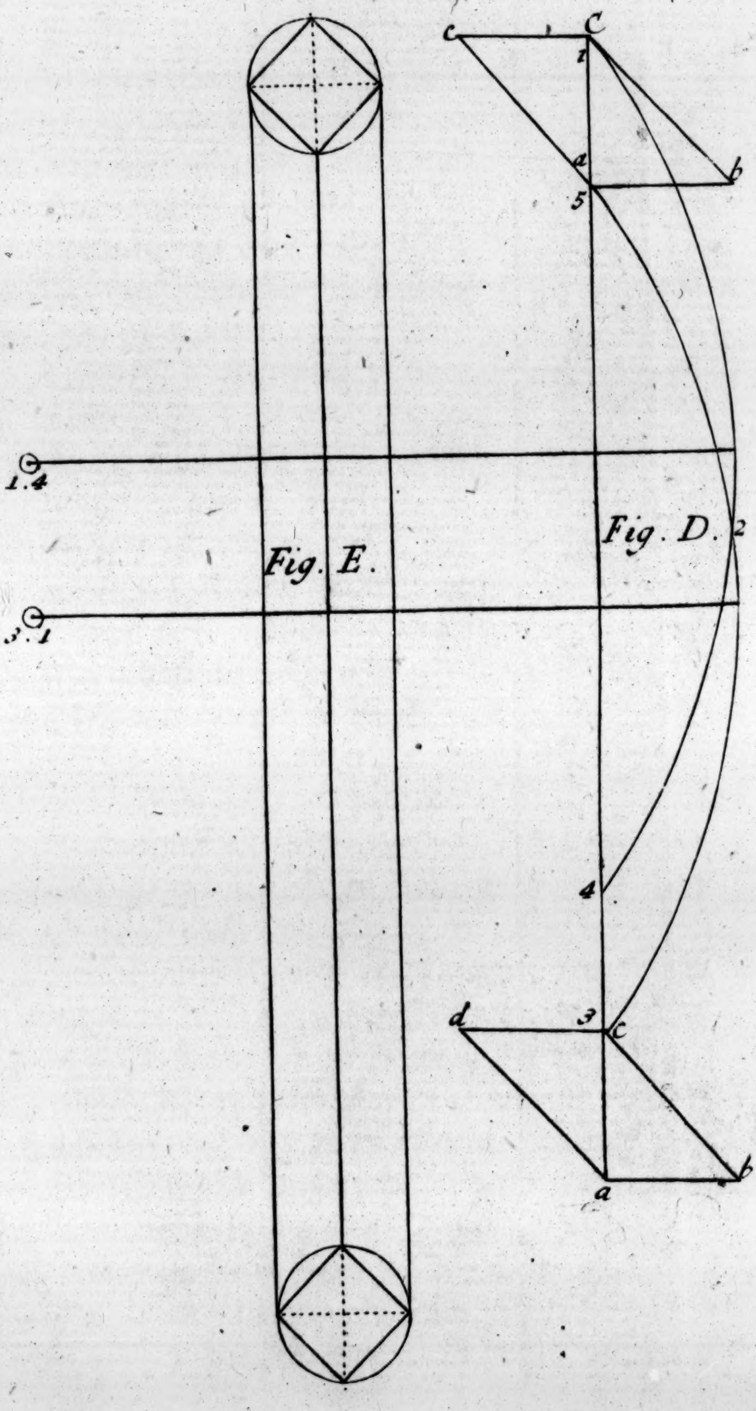
1.4
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Fig. E.
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Fig. D.
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every Step, as it is wrought round, may directly ſtand againſt the Square of the Nuel.

In Figure E, it may be obſerved, that if your Deſign is to work a twiſted Nuel, you muſt firſt ſquare the Piece big enough to make it round, and then a Square Twiſt, which may be conſidered from the Nature of Screw-work.

A TABLE of

The Scantling *or* Meaſuring *of the Timbers in a Ship, of near* 500 *Tuns.*

Keel of Elm in 4 Pieces if poſſible.	*Feet.*	*Inches.*
Squar'd in the Midſhips	1	2
Length of the Scarph	4	1
Bolts, 8 in Number, of the Bigneſs	0	0 $\frac{95}{100}$
Falſe Keel, Elm	0	3 $\frac{3}{10}$
Taper'd at the After-end thwart-ſhips	0	9 $\frac{2}{10}$
Stem of Oak in two Pieces, as aforeſaid.		
Breadth Fore and Aft	1	2 $\frac{8}{10}$
Thwart-ſhips	1	0 $\frac{98}{100}$
But as big as the Bowſprit upwards.		
Length	32	
Falſe Stem's Breadth	1	10 $\frac{9}{10}$
Thickneſs	0	8 $\frac{13}{100}$
Stern-poſt, Oak, in Legth	32	
Fore and Aft at the Head	1	5 $\frac{2}{10}$
Thwart-ſhips at the Head	1	5 $\frac{3}{10}$
Fore and Aft upon the Keel	2	1 $\frac{8}{10}$
Falſe Poſt Fore and Aft Allow that within-ſide	1	2
Falſe Poſt Fore and Aft Allow that without-ſide	0	9
Faſhion Pieces ſided	0	10

Tran-

	Feet.	Inches.
Tranſoms { Wing and Deck-ſided	0	11 $\frac{4}{10}$
Tranſoms { Thoſe below the Deck	0	10
Common Space between	1	1
Knees of every whole Tranſom ſided	0	10 $\frac{7}{10}$
The Wing Tranſom to have a long arm'd Knee	12	6
Space of Timber and Room	1	9 $\frac{1}{2}$
Floor Timber ſided	0	9 $\frac{4}{10}$
Up and Down on the Keel	1	2
In and Out at the Floor-head	0	10
Length	17	2
Top-timber Length	12	8
Fore and Aft } at the Head	0	8 $\frac{6}{10}$
In and Out } at the Head	0	2 $\frac{4}{10}$

And all other Timbers (as Foothooks) between the Floor and Top-timber head, to be ſcantled by a diminiſhing Line ſtruck from the Length of the Body, on the Girt ſet off from the Keel to the Top-timber Head.

Foot-hooks, Number of Tires, N°. 3.

	Feet.	Inches.
Length	13	3
Scarph, at leaſt	5	6
Thickneſs in and out at the Breadth	0	7 $\frac{11}{20}$
Lower Foot-hook ſhort of the Keel	0	11 $\frac{4}{10}$
Every other Floor-timber to be bolted through the Keel with a Bolt in Diameter	0	1 $\frac{18}{100}$
Hawſe Pieces in Number 4, Breadth	1	10
Keelſon ſcor'd into the Floor-timbers	0	1
Thwart-ſhips	1	3
Up and down	1	2
Thick Strakes on each ſide the wrung Heads, N°. 6.		
The middle one in Thickneſs	0	6 $\frac{6}{10}$
The Extreams in Thickneſs	0	5
Each in Breadth	1	1 $\frac{6}{10}$
Two Strakes of middle Bands in Thickneſs	0	5 $\frac{7}{10}$
One Strake next the Limber Boards	0	5 $\frac{7}{10}$
Two Strakes of Gun-deck Clamps { Upper thick-	0	6
Two Strakes of Gun-deck Clamps { Breadth	1	3 $\frac{1}{2}$
All the reſt of the Foot-waling in { Thickneſs	0	4 $\frac{2}{10}$
All the reſt of the Foot-waling in { Breadth	1	1

	Feet.	*Inches.*
Orlope Beams, N°. 8.		
Fore and Aft	0	11
Up and Down	0	$9\frac{7}{10}$
* Thoſe under the Store-rooms ſided	0	$8\frac{5}{10}$
Up and Down	0	$7\frac{9}{10}$
Bends of Riders N°. 4.		
Floor Riders Fore and Aft	1	$1\frac{4}{10}$
Up and down on the Keelſon	0	$9\frac{9}{10}$
In and Out at the Extreams	0	$10\frac{9}{10}$
Length	16	11
To be bolted in every 20 Inches Space, with Bolts in Diameter	0	$1\frac{18}{100}$
Foot-hook Riders Length of Scarph	6	$6\frac{6}{10}$
Fore and Aft	1	1
Up and Down	0	$9\frac{9}{10}$
Top-riders, if any, Fore and Aft	0	$9\frac{1}{10}$
In and Out	0	$8\frac{17}{20}$
Crutches Aft, N°. 2.		
Sided	0	$9\frac{5}{10}$
Each Arm to be in Length	4	$10\frac{1}{2}$
Step of the Main-maſt Fore and Aft	1	11
D°. Fore.maſt	1	$10\frac{1}{2}$
D°. Mizon-maſt	1	$2\frac{2}{10}$
Breaſt-hooks, to place one under each Deck, one under the Hawſe-holes, and in Hold before the Step of the Fore-maſt, N°. 4.		
To be in Length	10	9
Depth Up and Down	0	$10\frac{9}{10}$
To be bolted in every 20 Inches.		
The Well to be built with Oak Plank.		
Thickneſs	0	$2\frac{9}{10}$
Pillars to each Beam of the Gun-deck.		
Square	0	$5\frac{19}{20}$
Croſs Pillar ſquar'd	0	$7\frac{19}{20}$
Gun-deck Beams to round	0	$4\frac{8}{10}$
To be Fore and Aft	1	1
Up and Down	0	$11\frac{7}{10}$
To be Dove-tail'd into the Clamps	0	$2\frac{2}{100}$
And double Knee'd		

Each

	Feet.	Inches.
Each Knee ſided	0	8 $\frac{5}{10}$
The up and down Arm of the Hanging Knee Length	3	11
The other no leſs than	3	4 $\frac{1}{2}$
To be bolted in every 16 or 18 Inches, with Bolts Diameter	0	1 $\frac{6}{100}$
The Beams to lie one under, and one between each Port, except in the Main Hatch-way, and in the Wake of the Main-maſt.		
Clear of the Main Hatch-way fore and aft	6	8
Thwart-ſhips	5	8
Carlings, Tires of each ſide 2, and in ſome places leſs, according to the Tapering of the Ship.		
Carlings Depth up and down	0	7 $\frac{8}{10}$
Thwart-ſhips	0	10 $\frac{6}{10}$
Ledges to lie aſunder	0	8
Depth	0	3 $\frac{8}{10}$
Breadth	0	4 $\frac{5}{10}$
The Flat of the Deck Oak Plank, of	0	2 $\frac{9}{10}$
Port of each Side Nº. 11. fore and aft	2	8
Up and down	2	3
From the Deck Plank to the upper Part of the lower Cell	2	1
Cable Bit-pins, the aftermoſt ſquare at the Head	1	3 $\frac{5}{10}$
Foremoſt dº.	1	1
To continue the Subſtance below the Beam, and then to taper half at the Heel.		
Croſs-pieces one Inch deeper than the Square of the Pins, and to be fore and aft	1	5 $\frac{4}{10}$
Partners of the Main-maſt	0	7 $\frac{9}{10}$
Fore-maſt	0	7 $\frac{3}{10}$
Capſtand and Mizon-maſt	0	5 $\frac{5}{10}$
Lead Scuppers various in Number and Diameter, but of Lead that 10 Pound weight be a Foot in Meaſure.		
Standers, Number on each ſide 4.		
Sided	0	11 $\frac{6}{10}$
Spirkit-riſing, Thickneſs	0	4
Lining between the Ports	0	3
Partners or Step for the Bowſprit	0	6 $\frac{3}{20}$

Main

	Feet.	Inches.
Main Capſtand, Diameter at the Barrel	2	1
Upper Deck Clamps thick	0	$4\frac{3}{20}$
Beams the longeſt to round	0	7
Fore and Aft	0	$9\frac{4}{10}$
Up and Down	0	$8\frac{3}{10}$
Carlings, Depth	0	$5\frac{1}{20}$
Breadth	0	$6\frac{3}{20}$
Ledges, Depth	0	3
Breadth	0	$3\frac{7}{10}$
Knees ſided	0	$5\frac{9}{10}$
To be bolted in 18 Inches Square with Bolts of Diameter	0	$0\frac{77}{100}$
Standards on each Side, Nº 3.		
Sided	0	$7\frac{7}{10}$
Plank or Deal, in Thickneſs	0	$2\frac{3}{10}$
Ports Fore and Aft	2	4
Up and Down	1	$11\frac{5}{8}$
Height from the Deck Plank to the Cell	1	$6\frac{8}{10}$
Spirkit-riſing, in Thickneſs	0	3
String under the Ports prick'd home to the out-board Plank. String's Thickneſs	0	$4\frac{5}{10}$
And to be left without the Spirkit-riſing	0	$1\frac{2}{10}$
String above the Ports, to be ſcor'd ¾ of an Inch about the Timbers. Thickneſs	0	$2\frac{9}{10}$
Top-ſail Sheet and Jeer Bits Main, ſquare at the Head	0	$9\frac{3}{4}$
Long coming Carlings for the Gratings. Depth	0	$10\frac{1}{10}$
Breadth	0	$8\frac{7}{10}$
Bulk-head Brackets of the Steeridge and Fore-caſtle ſided	0	$7\frac{5}{10}$
Fore-caſtle Clamp of Oak in Thickneſs	0	$3\frac{3}{10}$
Breadth various, according to the Height from the Fore-caſtle Deck to the Ports.		
String in the Great Cabin of Elm, into which the Beams ſhall be dovetail'd and bolted in every 16 Inches.		
Bolts Diameter	0	$0\frac{77}{100}$
String cut on the Beveling of the Side	0	$10\frac{1}{10}$
Depth	0	$8\frac{7}{10}$
Thickneſs	0	$6\frac{3}{10}$

	Feet.	Inches.
Beams the longeſt to round	0	$9\frac{9}{10}$
Fore and Aft	0	$7\frac{2}{10}$
Up and Down	0	$4\frac{8}{10}$
To lie 2 Foot, or 2 Foot 4 Inches aſunder.		
Knees ſided	0	$4\frac{3}{10}$
Bolts Diameter	0	$0\frac{63}{100}$
Plank of the Deck in Thickneſs	0	2
Quarter-deck Ports { Fore and Aft	1	$7\frac{1}{2}$
Up and Down	1	$6\frac{3}{4}$
Height from the Deck	0	$11\frac{4}{10}$
Spirkit-riſing in Thickneſs	0	$2\frac{9}{10}$
Bits about the foremoſt Square	0	8
Cat-heads ſquare, or to be 2 Inches. Bigger Fore and Aft than Up and Down.		
Square	0	$11\frac{9}{10}$
To ſtave in every Foot	0	2
Length without the Side, according to the various Bluffneſs or Flaring of the Bow.		
But, as Cuſtomary	4	$3\frac{1}{3}$
Poop Beams to lie aſunder	1	$5\frac{4}{10}$
The longeſt to round	0	$9\frac{9}{10}$
Fore and Aft	0	$5\frac{1}{10}$
Up and Down	0	$3\frac{7}{20}$
Ports Fore and Aft	1	3
Up and Down	1	3
Height from the Cell	0	$10\frac{1}{10}$
Without Board.		
Plank wrought at the Bottom	0	$3\frac{9}{20}$
To faſten well with Trenels in Diameter	0	$1\frac{3}{4}$
Plank wrought at the Breadth, thick	0	5
At the Top-timber Head	0	2
Lower Wale, Up and Down	1	2
In and Out	0	$8\frac{1}{2}$
Upper Wale, Up and Down	0	$11\frac{9}{20}$
In and Out	0	8
Lower Chain-wale, Deep	0	$8\frac{7}{10}$
Thick	0	$4\frac{7}{10}$
Upper Chain-wale, Deep	0	$8\frac{7}{20}$
Thick	0	$4\frac{2}{10}$

Main

	Feet.	*Inches.*
Main Channels, Length	24	6
Breadth At the After End	2	
Breadth At the Fore End	1	11
Thickneſs	0	5 $\frac{4}{20}$
Number of Shrouds 6		
Fore Channels, Length	18	10
At Breadth the After End	1	8 $\frac{3}{4}$
At the Fore End	2	2
Thickneſs	0	4 $\frac{1}{4}$
Number of Shrouds 6		
Mizon Channel, Length	11	0
Breadth at the After End	1	2
Foremoſt End D°.	1	1
Thickneſs	0	3
Number of Shrouds 4		
Sheering Rail Depth at the Gunnel	0	5
Stern Tire of Brackets next above the Counter	1	$\frac{4}{10}$
Quarter-pieces ſided	1	6
Gallery Brackets ſided at the lower Lights	0	8 $\frac{7}{10}$
Rudder at the Head Fore and Aft	1	7 $\frac{5}{10}$
Rudder at the Head Thwart Ships	1	5
Fore and Aft allow	4	2
Rudder Irons, 6 Pair.		
Term Pieces or Drift Pieces ſided	0	9 $\frac{8}{10}$
Counter Rail to round upon the Flat of the Stern upwards	0	9
Outwards	0	7 $\frac{5}{10}$
Depth	0	10
Length of the Head afore the Stem	10	5
Lower Check ſided	0	9
Great Rail at the After End, beſides the Planſhire Fore and Aft	0	10 $\frac{5}{10}$
Bracket againſt the Stem ſided	0	11 $\frac{6}{10}$

CHAP. X.

Of MEASURING SHIPS.

IN order to Meaſure, or find how many Tuns a Ship will carry, Shipwrights generally make Uſe of the following

RULE.

Multiply the Length of the Keel by the greateſt Breadth, and that Product by the Half Breadth; then divide the laſt Product by 94, *and the Quotient will give the Tunnage required, for Merchant Ships; but for Men of War, the laſt Product muſt be divided by* 100.

Example. Suppoſe the Length of the Keel be 93 Feet 6 Inches, and the Breadth 32 Feet, required the Tunnage of the Ship.

```
Length of the Keel ———      93.5
Breadth ——— ——— ———           32
                            ----
                           1870
                          2805
                          ------
                          2992.0
Half Breadth ——— ———          16
                          ------
                         179520
                         29920
                        -------
                     94)47872.0(509.2
                        470
                        ---
                        ··872
                          846
                          ----
                          ·260
                           188
                           ---
                           ·72
```

Hence a Ship of the above Dimenſions, will carry 509 Tuns, and almoſt three Tenths of a Tun.

But it is often neceſſary to find the Tunnage of a Ship when ſhe is a Float, and conſequently the Length of her Keel cannot be meaſured. In ſuch Caſes Shipwrights make Uſe of the following

RULE.

From the extreme Length, ſubtract three fifths of the extreme Breadth, the Remainder is the Length of the Keel; then multiply the Length of the Keel by the extreme Breadth, and that Product by the Half Breadth; which laſt divide by 94 *for Merchant Ships, and by* 100 *for Men of War; the Quotient is the Tunnage, as before.*

But as in all Ships there is, or ought to be, a juſt Proportion obſerved between the Length by the Keel, the Breadth by the Beam, and the Depth in the Hold; as alſo for the Rake fore and aft, *&c.* the Uſe or Trade the Ship is intended for being conſidered: Therefore in finding the Tunnage of a Ship regard ought to be had to the Depth of the Hold, as well as to the Length and Breadth; tho' this is generally neglected in Practice. We therefore offer the following Method for meaſuring Ships, as more conſonant to both Reaſon and Experience.

It is certain, that if a Ship is gauged by taking only the Length of the Keel, from the Heel to the Fore-foot, as the Length of the Ship, all the Rake fore and aft is left; but to prevent this Error, they allow in Ships built for Burden, three fifth of the Breadth for the Rake fore and aft, therefore the Half of that, which is three tenths of the Breadth, added to the Length of the Keel, or ſubtracted from the whole Length of the Ship from Stem to Stern, reduces the Ship to very near a regular Solid, whoſe three Dimenſions being multiplied together (as in other regular Solids) gives the Solid Content, which divided by 93, the Quotient is the Tunnage of the Ship ſo meaſured.

To illuſtrate theſe Rules the better, we ſhall propoſe a Ship of the following Dimenſions.

	Feet	Inches
Length by the Keel	82	00
Whole Length, Rake and all	98	00
Conſequently the Rake fore and aft	16	00
Breadth at the Beam	26	06
Depth in the Hold	12	00
Length by the Keel	82	00
Half Rake fore and aft add	8	00
Sum	90	00

Multiply the Breadth in Feet in Decimals	26.5
By the Length	90
Product	2385
Multiply by the Depth in Feet	12
Divide (always) by	93)28620(307
	720
	60

The Burthen is 307 Tuns and $\frac{60}{93}$ or $\frac{20}{31}$, or about three Quarters of a Tun.

CHAP. XI.

Of Porportioning the RIGGING.

THE Center of the Maſts Places is general in all 3 Maſt Ships. Wherefore having laid down two Figures of Ships by direct Dimenſions, and fitted a Scale for them, the Centers of the Maſts for all other Ships may from thence be found. For as the Proportion any Ships Length is to theſe, ſo are the Centers of the Maſts Place one to another, and may be ſet off from the Stem or Sternpoſt upon either the Gun-deck, or deep Load Markline.

Having deſcribed the Place of each Maſt's ſtanding, I ſhall in the next place ſhew how the Length and Bigneſs of every Maſt is found, tho' from a Cuſtom ſo very different, that 'tis almoſt impoſſible to make it general.

MAIN-MAST.

The Main-Maſt is the firſt Mover, whoſe Proportiou is always found from ſome part of the Ship, either Length, Breadth, Depth, or Bulk of the Body, and from thence the Dimenſions of all the other Maſts and Yards are taken.

But to ſhew a little the different Methods made uſe of in this Matter; ſome will have it, that the Breadth and Depth of the Ship being added together, and multiplied by 3, and divided by 5, will give the Length of the Main-Maſt in Yards. Others again will take in the Length of the Keel for a Member to find the Proportion of this Maſt; which cannot be methodical, ſince two Ships may be of equal Length upwards, or equal in Bulk, and their Keels differ 10 Feet.

Now 'tis my Opinion, that the Length at the Lower Gundeck ought to be one principal Part in this Caſe, becauſe it is to be very near the Place of Bearing, and where the Body is divided between two Elements. 'Tis alſo near the Place where the Sails are managed; for the Yards, if not the Maſt, ought to be longer or ſhorter, according to the Ship's Length at that Seat. The extreme Breadth of the Ship ought to be another part, ſince the broader any Ship is, the more ſhe will reſiſt the Medium, and the more Sail will be requiſite for her. The Depth ſhould alſo be taken in, being almoſt of the ſame Nature as the Breadth.

To apply this therefore, I take the Length of the Gun-deck, the Main Breadth, and Depth in Hold, and add them together, and take the Half for the Length of the Main-Maſt in Feet, only ſubtracting the Depth of the Main-ſtep out of the Depth in Hold, which Depth of the Main-ſtep I allow to be one-ſixth of the Depth in Hold, *viz.*

	Feet	*In.*
Length on the Lower Gun-deck from the Inſide of the Rabbets	150	0
Breadth from the Outſide of the Plank	40	0
Depth in Hold 16 : 0 Take out 2 *Feet*, 8 *In.* remains	13	4
	203	4
	101	8

2 : 8
6)16 (2-8
4 — 13 : 4

Feet *In.*
3)101-8 (33 : 10 $\frac{2}{3}$
12

Length of this Ships Main-Maſt in Yards is 33 Yards, 10 Inches $\frac{2}{3}$.

The Length of the Main-Maſt being conſidered, the next thing requiſite is to make the Diameter in the biggeſt place ſuitable to it, or the Streſs it will bear. Which Proportion is alſo various, not only from the Bulk and Form of the Ship, but alſo from the Difference there is in the Strength of the Timber, and Nature of the Soil from which it is produced.

Let us ſuppoſe then three ſorts of Trees, one of *Riga*, another of *Gottenburgh*, and a third of *New-England*. A Maſt of 9 Inches Diameter of *Gottenburgh* Growth would be equal to one of 10 Inches and a half of *Riga* Growth, and thoſe two of ſuch a Bigneſs will be equal to a *New-England* Tree of 12 Inches Diameter. Not but that there may be a vaſt Difference between the Trees of each Country's Growth, not only from the Years they have ſtood, but alſo from the Soil where they grew.

It muſt be obſerved, that for every Yard in Length of a Main-Maſt for a Ship of the largeſt Size, there is an Inch allowed for the Diameter; for a middle Siz'd Ship $\frac{7}{8}$ or $\frac{6}{7}$ of an Inch; and for a ſmall one $\frac{4}{5}$ or $\frac{3}{4}$ of an Inch. But this is in ſome Meaſure to be proportioned to the Security the ſaid Maſts have by the Rigging.

FORE-MAST, TOP-MASTS.

The Fore-maſt ought to be $\frac{7}{8}$ or $\frac{8}{9}$ of the Main-maſt, the Fore-top-maſt, $\frac{3}{5}$ of the Fore-maſt; and the ſame proportion muſt be obſerved between the Main-top-maſt and the Main-maſt.

MAIN-YARD, FORE-YARD, TOP-SAIL-YARDS, &c.

The Main-yard is $\frac{7}{8}$ of the Main-maſt, the Fore-yard $\frac{7}{8}$ of the Main-yard, Top-ſail-yards $\frac{5}{9}$ of the Main-yards reſpectively, the

Top-gallant Yards half the Top-ſail Yards, and the Top-gallant-maſts half of the Top-maſts, or ſomething ſhorter.

BOWSPRIT, &c.

The Bowſprit ſhould be two-thirds of the Main-maſt for Length, or three-fourths of the Fore-maſt for ſmall Ships; and for Bigneſs, let it be nine-tenths, or more, of the Main-maſt. The Sprit-ſail Top-maſt is one-third of the Fore-top-maſt for Length, allowing three-fourths of an Inch in Diameter to every Yard in Length for the ſmalleſt of theſe Maſts or Yards, and not exceeding one Inch for the biggeſt.

MIZON-MAST.

The Mizon-maſt ought to be (in a third Rate) ſix-ſevenths of the Main-maſt, allowing two-thirds of an Inch Diameter for every Yard in Length. And this Length for the Mizon-maſt is when it ſteps in the Hold, but if upon the Lower Gun-deck, then the two-thirds of the Main-maſt will be ſufficient. But in a ſmall Ship five-ſixths of the Length of the Main-maſt will do for the Mizon-maſt, if it ſteps in the Hold.

MIZON-TOP-MAST.

The Mizon-top-maſt is one-third of the Mizon-maſt Stept in Hold, allowing three-fourths of an Inch for Bigneſs to a Yard in Length.

MIZON-YARD, &c.

The Mizon-yard is as long as the Fore-yard, allowing half an Inch in Bigneſs for a Yard in Length; Mizon-top-ſail Yard one-third of the Mizon-yard, allowing three-fourths of an Inch for Bigneſs. The Croſs-jack Yard is ſomething longer than the Main-top-ſail Yard, allowing to every Yard in length half Inch in Diameter. The Sprit-ſail Yard is five-ſevenths of the Fore-yard, and Sprit-ſail Top-ſail Yard half the Sprit-ſail Yard.

It was the Practice of a very good Maſt-maker, to take the Length of the Lower Gun-deck, and the extreme Breadth, and adding them together, to take half that for the Length of the Main-maſt in Feet, *viz.*

Length on the Deck, from Rabbet to Rabbet	150
Breadth extreme	40
	190

190 (*Yd.. Ft.*
3) 95 (31 : 2
2

Whence this Maſt, according to the Cuſtom, is 32 Yards.

Therefore either by this Calculation or that before given, may every three-maſted Ship's Main-maſt be proportion'd.

A General Proportion for the RIGGING *of a* Three Maſt Ship.

For the BOWSPRIT.

Horſe's Length ſix-ſevenths of the Bowſprit.

Circumference, one-ſeventh of the Diameter of ditto.

Dead-Eyes for ditto twice the Diameter of the Circumference of the Horſe.

Lanyard for ditto Length, one-third of the Horſe. Circumference, half the Horſe's.

Straps for ditto, equal in Bigneſs to the Horſe, and two-ſevenths of the Length.

Gammonings, Circumference, one-fifth of the Diameter of the Bowſprit, and 6 times its Length.

Wooldings, half the Bigneſs of the Gammoning, and five-ſixths of the Length.

Bob-ſtay, two-thirds of the Length of the Bowſprit.

Sheets for the Sprit-ſail Cabl'd, Circumference, $\frac{7}{25}$ of the Diameter of the Sprit-ſail Yard.

Length, ſeven times as long as that Yard.

Two 2 round Blocks, 4 times the Length of the Circumference of the Sheet.

Pendants Cabl'd, ſix-ſevenths of the Sheets for Bigneſs, and one-tenth of the Length.

Hallyards, equal in Bigneſs to the Sheets, and half the Length.

Lifts, equal in Bigneſs to the Pendants, and two-thirds of the Length of the Sheets.

Seizing to the Bowſprit, two-eights of the Bigneſs of the Lifts, and one-fifth of the Length.

Standing Lifts, equal in Bigneſs to the Horſes of the Bowſprit, and alſo in Length.

Lanyards, equal in Bigneſs to the Seizings, and half the Length.

Straps, three-fourths of the Bigneſs of the Standing Lifts, and one-third of the Length.

Braces, five-ſixths of the Lifts, and half as much longer.

Pendants, one-fifth bigger than the Braces, and one-twentieth of the Length.

Slings, twice as big in Circumference as the Braces, and one-fifteenth of the Length.

Seizing and Rackings, three-tenths of the Slings, and twice as long.

Horſes for the Yards, Circumference nine-twenty-fifths of the Diameter of the Yard, Length five-ſixths of the Yard.

Lanyards, one-third of the Horſes in Bigneſs, and five-ſixths of the Length.

Clew-lines, Circumference, $\frac{5}{25}$ of the Diameter of the Spritſail Yard, and 4 times the Length of the Yard.

Bunt-lines, four-fifths of the Clew-lines in Bigneſs, and two-thirds of the Length.

Reef-lines, half the Circumference of the Bunt-lines, and 5 times the Length of the Yard.

And after ſuch a Method may every individual Part of the Rigging be proportioned and calculated. But as it would be very troubleſome, I ſhall endeavour to abbreviate it, and make it ſomething eaſier. In the proſecution of which I ſhall obſerve this Method, only particularly to proportion the material Ropes, and bring all Lanyards, Pendants, Seizings, Straps for Blocks, Ratlings, Wormings, Runners of Tackles, and Tackle-falls, into a general Proportion as to their Bigneſs, ſhewing ſome Reaſons why it ſhould be ſo.

The Uſe of a Lanyard being to unite two other Parts together, as Stays and Shrouds, and ſeveral other Ropes that are very large, and connot be ſo well joined together, otherwiſe than by the help of ſmaller Ropes. I have obſerved it to be almoſt general, that the Lanyard is half the Circumference of the Ropes they ſecure, ſo that they are a quarter as ſtrong; that 4 ſuch Parts are equal to one Part of the great Rope. Tho' it is uſual to have 6 Parts applied, as Lanyards to every Rope, that they ſo ſecure; and yet very often the Lanyard is broke, and very ſeldom the Shroud. Which muſt certainly be owing to the motion of the Ship, when the Shrouds on one ſide being ſtretch'd by the Weight of the Maſt, the Lanyards on the other ſide grow ſlack, and by ſudden Jirks are fretted againſt the Wood in which they are reev'd, and ſo broke. For otherwiſe, in a regular Strain, the ſix Parts of the Lanyards of half the Circumference of the Rope they ſecure, muſt hold longeſt.

Wherefore ſince 6 Parts of a Lanyard of half the Circumference will be ſufficient to hold any ſuch Rope, there may be a general Proportion drawn, that where the Size of any Lanyard is required leſs in proportion to the Rope they ſo ſecure, as in Stays and ſeveral other Ropes, there the Number of Turns will render the Lanyard equal in Strength to the 6 Parts of thoſe which are half the Circumference of the Rope. And for the Space between, allow for every Inch the Dead-eye is in Diameter, 3 Inches and a quarter between each Dead-eye. And this is for Thwart-ſhips, but Fore and Aft they need not be ſo much, but in a cubical Proportion between the Length and Breadth of the Ship. For the Property in this Part is no otherwiſe to be conſidered than from the Motion of the Ship, ſince the ſhorter the Space, the better for the Lanyard, but the worſe for the Great Rope.

The Seizings may be one-ſixth of the Rope they ſeize, allowing ſuch a Number of Turns, as may be equal to double the Weight of a Cube or Die-ſquare, made by each reſpective Rope ſo ſeiz'd.

Straps of Blocks are generally in two Parts, and ſometimes in four, which ought to be equal in Strength to the Folds of the Tackle-fall, or any other Rope. And ſince 4 Parts of any Rope of 6 Inches Circumference, are near equal to 2 Parts of a Rope alike in Goodneſs, of 8 Inches and half in Circumference; thoſe two Parts will be ſuitable for a Strap to a Block that is uſed with 4 Folds, as a Tackle-fall, or any other running Rope. From whence may be derived a general Proportion for ſtrapping every

Block in a Ship, as to Bigneſs; but for the Length they are practically allowed to be three times the Length of the Block, or ſomething more, it being altogether unreaſonable to confine the Workman or Rigger to an Inch of Rope. But it ought to be obſerved, that ſuch a Length will do, when the Block is only ſeized with an Eye; for if Blocks are to be put over a Yard, or the like, the Property will be alter'd.

Pendants; their Circumference may be conſidered from the preceding Rule of Strapping Blocks; but the Length is various according to their Uſe.

Ratlings are one-ſixth of the Shrouds: Wormings one-eighth of the Rope.

Pendants of the Main and Foremaſt ought to be as big as the Shrouds, ſince they purchace a great Weight of Boats and Anchors.

The Runners are eleven-twelfths of the Pendants; and Tackle-falls half the Circumference of the Pendants.

But before I proceed any farther, I ſhall ſet down a few Abbreviations to contract a little the remaining Part, obſerving that all Rope is ſized as to its Bigneſs by the Circumference, which in every Article ſhall be firſt mentioned.

Cir. ——— *Circumference.*
Di. ——— *Diameter.*
Le. ——— *Length.*
D°. ——— *The ſame.*

For the SPRITSAIL TOP-MAST.

SHrouds, Cir. two-fifths of the Di. of the Sprit-ſail Top-maſt in the Cap Le. two-thirds of the Top-maſt's Length.

Pendants of Back-ſtays, or Crane-line, as ſome call it, as big as the Shrouds, and one-fifth of the Length.

Falls of the Pendants, half the Pendant, and 6 times as long.

Tie of the Hallyards, as big as the Shrouds.

Hallyards, one-fourth of the Tie, and 3 times as long as the Top-maſt. Le. of the Tie one-third of the Hallyards.

Lifts, as big as the Hallyards, and twice as long.

Braces, two-thirds of the Lifts, and twice as long.

Pendants of Braces, as big as the Lifts, and one-tenth of the Le. of the Brace.

Parrel Rope, as big as the Pendants of the Brace, and for every Inch the Maſt is through in the Cap, allow 2 Feet for the Le. of the Parrel Rope.

Clew-lines, as big as the Lifts, and 5 times as long as the Hallyards.

For the FORE-MAST.

PEndants of Tackles, Cir. two-ſeventh of the Di. of the Fore-Maſt in the Partners, and for every Inch in Circumference allow one Fathom for Length.

Runners of the Tackle, eleven-twelfths of the Pendant, and 4 times the Length.

Tackle Falls, half the Pendants, and 9 times the Length.

Shrouds, Cir. as big as the Pendants, and eight-elevenths of the Le. of the Fore-maſt.

Lanyards as before, Ratlings D°. Wormings D°.

Cat-harping Legs and Falls equal in Bigneſs, being one quarter of the Shrouds. Length twice that of the Fore-yard.

Fore Stays, Cir. half the Di. of the Fore Maſt, and eight-ninths of the Length.

Lanyard, ſeven-twentieth of the Stay, by reaſon this Lanyard's Strength is made up by the Number of Tuns extraordinary.

It may alſo be obſerv'd, that the Le. of the Lanyard for the Stay, to the Le. of each Lanyard for the Shroud, is as 2 to 1.

Worming the ſame as before.

Collar of the Stay, nine-tenths in bigneſs to the Stay, and one quarter of the Length.

Woolding of the Maſt, for every Inch the Maſt is in Di. at the Partners, allow one-eighth for the Cir. of Woolding; and for the Le. allow 8 times the Le. of the Maſt.

Crow-feet for the Top, as big as the Ratling, and as long as the Cat-harpings. Tackle for D°. equal in Bigneſs and one-ſeventh of the Length.

Jeers, five-ſixths of the Shrouds, and 6 times the Le. of the Yard.

Laſhers for the Yards as big as the Lanyards of the Shrouds, and twice as long as the Stay.

Tackles for Boats, as big as the Woolding, and half as long as the Falls of the Runner.

Lifts, half the Shrouds for Bigneſs, and 4 times as long as the Fore Maſt.

Straps for the Cap, as big as the Lifts, and as long as the Collar of the Stay.

Braces, as big as the Lifts, and within two-fiftieth Parts as long.

Pendants, as big as the Braces, and one-tenth as long. Which may be a general Rule for the Length of the Pendants of the Braces.

Parrel Rope, Cir. one-ſixth of the Di. of the Maſt in the Partners. And for every Inch the Maſt is there, allow 3 Feet for Length.

Nave-line, as big as the Cat-harpings, and as long.

Racking and Seizing for the Parrel, two-thirds of the Nave-line, and four-fifths of the Length.

Horſes for the Yard worn Rope, nine-tenths of the Jeers for Bigneſs, and ten-elevenths of the Yard for Length.

Lanyards, two-thirds as big, and half as long.

Puddening for the Yard, as big as the Jeers, and 12 Cir. of the Yard in the Slings.

Fore Sheets, as big as the Jeers, and 5 times the Length of the Fore Maſt.

Stoppers, as big as the Fore Sheets, and one-twentieth of the Length.

Lanyards, as big as the Worming of the Shrouds and two-thirds of the Length of Stoppers.

Fore Tacks, as big as the Sheets, but taper'd, and half as long.

Bow-lines, as big as the Braces, and ſeven-eighths of the Length.

Laſhers, five-ſixths of the Bow-lines, and one-ſeventh of the Length.

Bow-line Bridles, as big as the Bow-lines, and one-tenth of the Length.

Clew-garnets, as big as the Braces, and as long.

Bunt-lines, two-thirds of the Clew-garnets, and as long as the Jeers.

Leech-lines, as big as the Bunt-lines, and half as long.

Reef-lines, half the Leech-lines, and 4 times the Le. of the Yard.

Rope-bands and Ear-rings, three-fourths of the Leech-lines, and 7 times as long as the Yard.

For the FORE TOP-MAST.

SHrouds, Cir. one-third of the Di. of the Top-maſt, and $\frac{13}{14}$ of the Length.

Lanyards as aforeſaid, Ratlings D°.

Pendants of the Top-rope, as big as the Fore Shrouds, and as long as the Fore Yard.

Falls of the Top-rope ſeven-twelfths of the Pendants and 5 times as long as the Fore Top-maſt.

Pendants of Burton Tackles, Cir. one quarter of the Di. of the Top-maſt, and two-thirds of the Length.

Burton-falls, two-thirds of the Peadants, and 7 times the Length.

Puttock-ſhrouds, as big as the Top-rope Fall, and two-thirds of the Length all together.

Standing Back-ſtay, as big as the Shrouds, and nine-thirteenths of the Le. of the Fore-maſt and Fore Top-maſt put together: Each of them Standing Back-ſtays.

Lanyards as aforeſaid.

Stays, Cir. nine-twenty-fifths of the Di. of the Fore Top-maſt, and as long as the Back-ſtays.

Lanyards, as aforeſaid.

Runner, as big as the Stay, and twice as long as the Fore Top-maſt.

Top-ſail Hallyards, five-ninths of the Runner, and twice the Length, and half the Length of the Top-maſt more.

Lifts, as big as the Hallyards, and 4 times the Le. of the Stay.

Beckets upon the Cap, as big as the Lifts, and one quarter the Le. of the Pendants of the Burton.

Slings, worn Rope, as big as the Puttock-Shrouds, and 6 times as long as the Beckets.

Parrel Rope, Cir. one quarter of the Di. of the Top-maſt in the Cap. And for Le. allow 3 Feet for every Inch the Top-maſt is in the Cap.

Racking, one quarter of the Parrel Rope, and one-ſixth longer.

Horſes for the Yard, worn Rope, as big as the Parrel Rope, and eighteen-nineteenths of the Le. of the Yard for Length.

Top-ſail Sheets, Cir. one-third of the Di. of the Fore Yard in the Slings, and twice the Le. of the Fore Yard each.

Span worn two-fifths of the Sheet, and one-ſeventh of the Length.

Laſhers, as big as the Racking, and half as long as the Lanyard of the Stay.

Bow-lines, Cir. two-thirds of the Fore Bow-lines, and as long as the Top-ſail Hallyards.

Bridles, as big as the Bow-lines, and two-ſevenths of the Length.

Clew-lines, as big as the Top-ſail Hallyards, and 8 times the Length of the Fore Top-maſt, and half its Length.

Bunt-lines, as big as the Bow-lines, and half as long as the Clew-lines.

Reef-tackle
- Tye, as big as the Clew-lines, and half as long as the Bow-line Bridles.
- Fall, three-fifths of the Tye, and one-third of the Length of the Bow-lines.

Leech-lines, as big as the Bunt-lines, and as long as the Reef-tackle Fall.

Braces, as big as the Clew-lines, and three-quarters of the Length.

Pendants of Braces as big as the Braces, and one-ſixteenth of the Length.

Stay-ſail Stay, worn ſeven-ninths of the Stay, and three-ſevenths of the Length.

Cringles worn, as big as the Lanyards, and half the Length of the Falſe Stay together.

Lanyards, two-ſevenths of the Stay, and half the Length.

Hallyards, as big as the Reef-tackle Fall, and 3 times the Length of the Stay.

Sheet, as big as the Hallyards, and two-thirds of the Length.

Tack, one-third bigger than the Sheets, and one-fifth of the Length.

Reef-lines, half as big as the Sheet of the Stay-ſail, and 6 times as long as the Fore Top-ſail Yard.

Rope-bands and Ear-rings, one-third bigger than the Reef-lines, and one-ninth longer together.

For the TOP-GALLANT-MAST.

SHrouds, Cir. two-fifths of the Diameter of the Maſt, and twelve-thirteenths of the Maſt's Length.

Lanyards, as aforeſaid.

Puttock Shrouds, as big as the Top-gallant Shrouds, and half of the Length.

Stay, three-quarters of the bigneſs of the Shrouds, and twice as long as the Fore Top-Maſt.

Tye of the Hallyards, as big as the Shrouds, and five-ſixths of the Length of one Shroud.

Hallyards, three-quarters of the Tye, and as long as the Fore-Maſt, Top-Maſt, Top-gallant Maſt, and Stump of D^{o}. put together in their extreme Lengths.

Lifts, half the Shrouds, and two-thirds of the Hallyards Length together.

Braces, as big as the Lifts, and 3 times the Le. of the Stay.

Pendants, as big as the Braces, and one-eleventh of the Le.

Parrel Rope, as big as the Pendants. Le. 2 Feet and a half for every Inch the Top-gallant Maſt is in the Cap.

Bow-lines, as big as the Braces, and three-quarters of the Le.

Bridles, as big as the Bow-lines, and one-quarter of the Le.

Clew-lines, as big as the Hallyards, and as long as the Braces.

For the MAIN-MAST.

PEndants of the Tackles, Cir. $\frac{6}{22}$ of the Diameter of the Main-Maſt in the Partners. Le. half the Le. of the Maſt.

Runners, twelve-thirteenths of the Pendants, and as long as the Fore Runners.

Tackle-falls, ſeven-thirteenths of the Pendants, and 8 times the Length.

Pendant of the Garnet, five-ſixths of the Runners of the Tackle, and $\frac{11}{24}$ of the Length.

Guy of the Garnet, four-fifths of the Pendant, and two-thirds of the Length.

Garnet Fall, as big as the Main Tackle Fall, and half the Length.

Shrouds, as big as the Pendants, and five-ſevenths of the Length of the Main Maſt.

Lanyards, as aforeſaid. Ratling D°. Worming D°.

Cat-harpings Legs and Falls, twice as big as the Worming, and twice as long as the Main Yard.

Stay, Cir. half the Di. of the Maſt, and $\frac{20}{21}$ of the Maſt's Le.

Lanyard, $\frac{5}{24}$ for bigneſs of the Stay, and two-thirds of the Le.

Laſher to the Fore Maſt, half the Lanyard, and three-fifths of the Length.

Worming, one-ſixth of the Stay, and 5 times as long.

Collar, three-quarters of the Stay for Bigneſs, and ſeven-ſixteens of the Length.

Woulding of the Maſt, for every Inch the Maſt is in Di. at the Partners, allow one-ninth of an Inch for the Cir. of the Rope, and 9 times the Length of the Main Maſt for Length.

Crow-foot for the Top, as big as the Worming, and as long as the Cat-harpings.

Tackle for D°. equal in Bigneſs, and one-eighth of the Length.

Jeers, eleven-thirteenths of the Shrouds, and 8 times the Length of each Shroud, ſo that each Jeer is 4 times the Length of each Shroud.

Laſhers to the Yard, ſix-elevenths of the Jeers, and four-ſevenths of the Length of one Jeer.

Tackles for the Boats, five-ſevenths of the Main Tackle, and as long as the Garnet.

Lifts, as big as the Main-tackle Falls, and twice as long as the Main Maſt and Yard put together, with two-fifths of the Length of the Main Yard added to them.

Strap for the Cap, as big as the Lanyards of the Shrouds, and 5 times as long as the Cap.

Braces, ſix-ſevenths of the Lifts, and 5 times the Length of the Main Yard.

Pendants, as big as the Braces, and one-tenth of the Length.

Parrel Rope, Cir. one-ſixth of the Di. of the Maſt. And for every Inch the Maſt is, allow 3 Feet for Length, as aforeſaid.

Nave-line, three-quarters of the Cat-harpings, or of equal Size and Length.

Racking and Seizing, one-quarter of the Parrel, and half as long again.

Horſes for the Yard, worn Rope, nine-elevenths of the Jeers, and $\frac{20}{21}$ of the Length of the Main Yard.

Lanyard, half the Horſe, and one-third of the Length.

Puddening to the Yard, as big as the Jeers, worn Rope, and 12 Cir. of the Yard in the Slings.

Sheet Cabl'd, as big as the Runners of the Main Tackle, and one-fifteenth longer than the Braces.

Stoppers, eight-ſixths of the Sheets, and $\frac{1}{21}$ of the Length.

Lanyards, half the Nave-line, and two-thirds of the Stoppers for Length.

Tacks taper'd, as big as the Shrouds, and half the Length of the Braces.

Luff Tackles, ſix-thirteenths of the Tack, and ſeven-eighths of the Length.

Bow-lines, as big as the Lifts, and one-fifth longer than the Tacks.

Bridles, ſix-ſevenths of the Bow-lines, and two-ſevenths of the Length.

Tackle, five-ſixths of the Bridles, and of equal Length.

Clew Garnets, five-ſixths of the Braces, and five-ſixths of the Length.

Bunt-lines, two-fifths of the Clew Garnets, and half as long again.

Leech-lines, as big as the Bunt-lines, and half as long.

Stay-ſail Stay, one-third of the Main-ſtay, and three-quarters of the Length.

Lanyard, as aforeſaid.

Cringles worn, five-eights of the Stay, and as long as the Lanyards together.

Hallyards, half the Stay, and twice as long.

Sheet, five-eights of the Stay, and one-third of the Length.

Tack, three-quarters of the Stay, and half the Le. of the Sheet.

Studding-ſail Hallyards, as big as the Stay-ſail Tack, and 3 times the Le. of the Main-maſt, one quarter the Le. added unto it.

Sheet, five-ſixths of the Hallyards, and one-quarter the Length.

Tack, as big as the Hallyards, and half the Length.

Reef-lines, three-quarters of the Leech-lines, and 4 times the Length of the Main Yard, and two-thirds.

Rope-bands and Ear-rings, as big as the Reef-lines, and half as much longer, taken altogether.

For the MAIN TOP-MAST.

SHrouds, Cir. $\frac{9}{29}$ of the Di. of the Top-maſt in the Cap, and $\frac{16}{17}$ of the Le. of the Top-maſt.

Lanyards, as before.

Ratling, two-ninths of the Shrouds, and $\frac{15}{16}$ for Le. of all the Shrouds.

Pendant of the Top Rope, Cir. $\frac{6}{29}$ of the Di. of the Top-Maſt. For Le. $\frac{12}{13}$ of the Main-Maſt.

Top Rope Fall, two-thirds of the Pendant, and 3 times the Length.

Pendants of Burtons, ſeven-ninths of the Shrouds, and half as long as the Pendant of the Top Rope.

Fall, four-ſevenths of the Pendants, and 6 times as long.

Puttock Shrouds, eight-ninths of the Top-maſt Shrouds, two-fifths of the Length.

Standing Back-ſtays, as big as the Shrouds, and nine-thirteenths of the Main Maſt and Main Top-maſt put together, for all of them.

Lanyards, as aforeſaid.

Stay Cabl'd, as big as the Shrouds, and ſix-ſevenths of the Le. of the Main Maſt and Main Top Maſt put together.

Runners of the Top-ſail Hallyards, Cir. half the Di. of the Top-ſail Yard, and twice as long as the Main Top-maſt.

Hallyards, three-fifths of the Runner, and twice the Length, with the Length of the Main Top-maſt added to it.

Lifts, half the Runner, and 8 times the Length of the Main-Top-ſail Yard.

Beckets at the Cap, as big as the Lifts, and 6 times the Length of the Cap.

Braces, as big as ths Lifts, and $\frac{13}{14}$ of the Length.

Pendants as big as the Braces, and one-tenth of the Length.

Beckets about the Mizon-Maſt, as big as the Main Top-ſail Hallyards, and as long as the Beckets at the Main Top-maſt Cap.

Slings, worn Rope, as big as the Mizon Beckets, and 4 times the Length.

Parrel Rope, Cir. one-quarter of the Di. of the Top-maſt in the Cap; and for Length allow 3 Feet to an Inch, as aforeſaid.

Racking, one-quarter of the Parrel, and as long as the Slings.

Horſes for the Yard worn, as big as the Parrel Rope, and $\frac{18}{19}$ of the Yard for Length.

Sheets, Cir. half the Diameter of the Top-ſail Yard, and ſix-ſevenths of the Length of the Braces.

Span, worn Rope, half the Sheets, and one-fifteenth of the Le.

Laſhers, three-quarters of the Ratling, and one-third longer than the Length of the Span.

Bow-lines, as big as the Hallyards, and $\frac{14}{15}$ of the Length.

Bridles, as big as the Bow-lines, and five-fourteenths of the Length.

Clew-lines, as big as the Bow-lines, and 8 times as long as the Main Top Maſt, and half as long.

Bunt-lines, two-thirds of the Clew-lines, and half as long.

Leech-lines as big as the Bunt-lines, and ſeven-ſeventeenths of the Length.

Reef Tackle Tyes, as big as the Braces, and as long as the Pendants of the Braces.

Fall, three-fifths of the Tye, and 3 times as long.

Stay-ſail Stay, worn, one-ninth of the Stay, and two-fifths of the Length.

Lanyards, as aforeſaid.

Cringles worn, four-ſevenths of the Stay, and as long as the Lanyards together.

Hallyards, as big as the Reef Tackle Fall, and twice as long as the Stay.

Sheet, as big as the Hallyards, and five-ſixths of the Length.

Tack, as big as the Leech-lines, and one-third of the Lanyard.

Studding-ſail Hallyards, as big as the Stay-ſail Stay, and 4 times as long as the Main Top-maſt, and three-quarters of the Length of the Top-maſt added to it.

Sheet, four-fifths of the Hallyards, and one-ſeventh of the Le.

Tack, as big as the Sheet, and one-quarter of the Length.

Reef-lines, half as big as the Leech-lines, and 4 times the Length of the Main Top-ſail Yard, with one-third of the Length added unto it.

Rope-bands and Ear-rings, as big as the Reef-lines, and half longer, put together.

For

For the MAIN TOP-GALLANT MAST.

SHrouds, five-ninths of the Top-maſt Shrouds, and $\frac{12}{13}$ of the Top-gallant Maſts Length.

Lanyards, as before.

Puttock Shrouds, as big as the Top-gallant Shrouds, and half of the Length.

Stay, three-quarters of the Shrouds, and twice the Le. of the Topmaſt, and one-eighth of the Length.

Tye of the Hallyards, as big as the Shrouds, and one-ſixth of the Le. of the Stay.

Hallyards, three-fifths of the Tye, and twice as long as the Main-maſt.

Lifts, as big as the Hallyards, and eight-ninths of the Stays Length together.

Braces, two-thirds of the Lifts, and three times the Length.

Pendants, as big as the Braces, and one-twelfth of the Length.

Parrel Rope, as big as the Pendants, allowing 2 Feet in Le. for every Inch the Top-gallant Maſt is in the Cap.

Bow-lines, as big as the Lifts, and the Le. of the Braces.

Bridles, as big as the Bow-lines, and one-twelfth of the Length.

Clew-lines, as big as the Bow-lines, and twice as long as the Hallyards.

For the MIZON-MAST.

SHrouds, Cir. $\frac{9}{29}$ of the Di. of the Mizon Maſt in the Partners. Le. two-thirds of the Maſt, if it ſteps in the Hold, and eight-ninths if on the lower Deck.

Lanyards, as before. Ratling D°.

Pendants, ſeven-ninths of the Shrouds. Le. two-thirds of one Shroud.

Fall, five-ſevenths of the Pendants, and 7 times the Length.

Stay, as big as the Shrouds, and as long as the Maſt, if it ſteps in Hold.

Lanyards, as before.

Collar, eight-ninths of the Stay, and five-ſixths of the Length.

Crow-foot for the Top, one-eighth of the Shrouds, and as long as the Stay.

Tackle for D°, as big, and one quarter of the Length.

Jeer, eight-ninths of the Shrouds. Le. twice that of the Mizon Maſt, if it ſteps in Hold, and half that Length.

Laſher, five-eighths of the Jeers, and one-fifth of the Length.

Parrel Rope, as big as the Laſhers, and for Le. allow 2 Feet, as aforeſaid.

Truſs, as big as the Parrel Rope, and twice as long as the Mizon Maſt ſtept on the Deck.

Slings, as big as the Shrouds, and as long as one Shroud.

Sheet, ſeven-ninths of the Shrouds, and as long as the Truſs.

Tack, five-ſeventh of the Sheet, and one-ſixth of the Length.

Bow-lines, as big as the Tack, and as long as the Slings put together.

Middle Brails, } $\frac{4}{5}$ of the Bow-lines for Bigneſs, and for Le.
Main Brails, and } 6 times the Le. of the Mizon Maſt ſtept in
Peek-brails, } Hold, and $\frac{1}{4}$ of ſuch a Le. added to it.

Lacing for the Mizon, half the Brails, and 3 times as long as the Mizon Yard, and one-third of the Le.

Stay-ſail Hallyards, as big as the Brails, and as long as the Sheet.

D°. Sheet, as big as the Mizon Tack, and half the Le. of D°. Bow-lines.

Tack, four-fifths of the Sheet, and three-quarters of the Le. of D°.

For the CROSS-JACK YARDS.

Standing Lifts, as big as the Mizon Bow-lines, and three-quarters of the Length.

Lanyards, three-fifths of the Lifts, and two-thirds of the Length.

Braces, three-fifths of the Lifts, and 6 times the Length.

Pendants, four-fifths of the Lifts for Bigneſs, and one-fifteenth of the Le. of the Braces.

Slings, as big as the Mizon Sheet, and two-thirds the Le. of the Standing Lifts.

For the MIZON TOP-MAST.

SHrouds, as big as the Main Top-gallant Maſts, and as long as the Mizon Top-maſt.

Lanyards, as before.

Puttock Shrouds, as big as the Top-gallant Maſt Shrouds, and as long as the Lanyards.

Stay, as big as the Shrouds, and twice the Le. of the Top-maſt.

Lanyards, as before.

Tye, as big as the Stay, and ſeven-eighths of the Le. of the Top-maſt.

Hallyards, four-fifths of the Tye, and twice the Le. of the Mizon Top-maſt ſtept on the Deck.

Liſts, three-fifths of the Shrouds, and 5 times the Le. of the Mizon Top-maſt both together.

Braces, as big as the Liſts, and 8 times the Le. of the Top-maſt, and half that Length.

Pendants, as big as the Braces, and one-fourteenth of the Length.

Parrel-Rope, as big as the Pendants, allowing two Feet in Le. for every Inch the Maſt is in the Cap.

Sheets, as big as the Shrouds, and $\frac{16}{17}$ of the Braces for Length.

Bow-lines, two-fifths of the Sheets, and equal in Length.

Bridles, as big as the Bow-lines, and one-ſixth of the Length.

Clew-lines, as big as the Braces, and as long as the Bow-lines.

Other Neceſſary ROPES.

VIol cabl'd, as big as the Fore Stay, and the Le. of the Gun-deck, and five-thirteenths of that Length.

Straps, ſeven-tenths of the Viol, and one-fifth that Length.

Laſhers, half the Straps, and twice their Length.

Pendant of the Winding Tackle, four-fifths of the Viol, and four-fifths the Le. of the Main Maſt.

Fall of D^{o}. half the Viol, and 3 times the Le. of the Pendant.

Pendant of the Fiſh-tackle, $\frac{13}{16}$ of the Pendant of the Winding Tackle, and one-third of the Le. of the Gun-deck.

Fall of D^{o}. ſeven-thirteenths of the Pendant, and 4 times as long.

Cat Ropes, nine-thirteenths of the Pendant of the Fiſh-tackle, and 7 times the Breadth of the Ship, both of them together, for Length.

Lanyards, as aforeſaid.

Stoppers of Anchors, $\frac{11}{13}$ of the Pendant of the Fiſh-tackle, and each of equal Le. to the Pendant.

Shank-painters, as big, and five-ſevenths of the Length.

Stoppers at the Bit, four-fifths of the Viol for Bigneſs, and near 3 Feet long.

Seizings, one-twelfth of the Stoppers, allowing 2 Fathom and a half to one Fathom of the Stoppers for Length.

Lanyards, three-eights of the Stoppers, and ſix-tenths of the Le. of the Seizings.

Buoy Ropes Cabl'd, as big as the Pendant of the Fiſh-tackle, and each as long as the Cat-rope ſingle.

Buoy-ſlings, ſeven-thirteenths of the Buoy-ropes for Bigneſs.

Gun-ſlings, ſeven-eighths of the Winding Tackle Pendants, for Bigneſs.

Butt-ſlings, ſix-ſevenths of the Gun D°.

Hogſheads-ſlings, four-ſixths of the Buts.

Nut-ſlings of the Guns, three-fourths of the Hogſheads.

Horſes in the Head, worn, ſeven-elevenths of the Gammoning, and 5 times the Le. of the Head, on a middle Line, from the Stem to the Fore-part of the Lion, both.

Lanyards, as aforeſaid.

Poop Ladders, worn, as big as the Mizon Jeers, and 7 times the Ship's Draught of Water Abaft for Le. both of them.

Middle Rope, one-third of the Sides, and ſeven-ninths of the Length.

Laſher, two-thirds of the Middle Rope, and four-ſevenths of the Length.

Puttock Staves, as big as the Mizon Shrouds.

Cable Bends, five-elevenths of the Shank-painters or Stoppers for Bigneſs.

Entring Ropes, generally 3 Inch Rope.

Port Ropes, for every 6 Inches the Port is Square, allowing half an Inch for the Circumference of the Rope.

Puddenings of Anchors, as big as Cable-bends.

Seizings, one-quarter of the Puddenings.

For the LONG-BOAT.

MAin Stay, as big as the Mizon Top-maſt Shrouds.

Tye D°. Hallyards, three-fifths of D°.

Pendants of Burton, one-fifth more than the Stay. Fall two-thirds of the Tye.

Fore Sheets, half the Burton-fall. Hallyards D°.

Main Sheet, as big as the Burton-fall. Tack D°.

Boat-rope cabled, as big as the Buoy-ropes, and for Le. let it be the Le. of the Ship aloft, extream.

Gueſt Rope, ſeven-thirteenths of the Boat Rope, and one-third longer.

Painter, half the Boat Rope, and one-fifth of the Le.

Yard Rope, half the Hallyards, and twice the Length of the Main-Stay.

For the PINNACE.

MAin Sheet, as big as the Long-boat's Fore Sheets.

Fore Sheets, ſeven-eighths of the Main Sheets.

Boat Rope cabl'd, eight-elevenths of the Long-Boat's Rope for Bigneſs, and as long as the Gueſt Rope.

Gueſt Rope, ſeven-eighths of the Boat Rope, and ſeven-eighths of the Length.

Painter, five-ſevenths of the Gueſt Rope, one-ſixth of the Length.

The ſeveral Sizes of STRAPPINGS and SEIZINGS.

Inch.		
6	——	4 times the Length of one Main Shroud, or 40 Fathom.
5½	——	½ that Le. of the 6 Inches.
5	——	¾ of the 6 Inches.
4½	——	As much as of 6 Inches.
4	Rope--	D°.
3½	——	D°.
3	——	D°.
2½	——	¼ as much more of this than of 3 Inch.
2	——	D°.
1½	——	As much as of 6 Inches.

And this is ſufficient to ſtrap every Block belonging to all the Rigging.

SEIZINGS.

Inch.		
2	——	As much as of the 5 Inch Strapping in Fathoms.
1½	Rope -	⅔ of the 2 Inch.
1	——	11 times as much as of 1 Inch and ½.
¾	——	Dº.

Spun Yarn, for every Inch the Main Stay is in Di. allow 5 Hundred Weight.

To every Hundred Weight of Spun Yarn allow 3 tarr'd Lines.

To every tarr'd Line allow three-quarters of a Pound of tarr'd Mar-line.

To every 30 tarr'd Lines allow one White Line.

To every White Line allow one Pound and half of White Mar-line.

To every Hundred Weight of Spun Yarn allow 8 Yards and half of old Canvas.

To every 8 Hundred Weight of Spun Yarn allow half a Barrel of Tar.

For every Yard the Main Maſt meaſures on the Superficies that's paid with Roſin, allow one Pound three quarters of Roſin to pay all the Maſts.

To every Pound of Roſin allow one Pound and two-thirds of a Pound of Tallow.

For every 15 Pound of Roſin allow one Gallon of Oil.

To every Gallon of Oil allow 2 Barrels of Blacking, which is for the Maſts Heads and Yards to pay them.

For every Fathom of Woulding allow 5 Nails.

To every 300 of Nails allow one Leather Bucket.

To every White Line allow 2 Pound and half of Twine, and two Log-lines.

To every Main Shroud allow 3 Trucks for the whole Rigging.

To every Barrel of Tar allow one Bruſh.

And for every four Barrels of Blacking one Bruſh.

A TABLE *of the Thickneſs of all* ROPES *belonging to any* SHIP, *from a Maſt of* 12 *Inches to* 34 *Inches through.*

The USE of the TABLE.

FInd the Diameter of the Main-maſt at the Top of the *Column*, and under that, and againſt the *Name of the Rope*, you have the *Thickneſs* of the ſaid Rope.

EXAMPLE:

Suppoſe in a Ship whoſe Main-maſt is 30 Inches through, and I deſire to know the *Thickneſs* of the Main-ſtay: I look for the *Maſt of* 30 *Inch.* at the top of the Table, *Page* 126, and under it, againſt [Stay] I find 15; which ſhews, that a Ship whoſe Main-maſt is 30 Inches through, or in Diameter, requires a Main-ſtay of 15 Inches.

Again: If the Fore-top-gallant Stay of the ſame Ship is required, look in *Page* 132, for *The Bigneſs of Fore-top-gallant Rigging*; you will, under 30, the Diameter of the Main-maſt, find 2 Inches the *Thickneſs* of the Fore-top-gallant Stay. And ſo in all others.

The Bigneſs of the Rigging for theſe Main-Maſts, and Main-Top-Maſts.
The Fore-Maſt to theſe Maſts followeth in the next Page.

	Maſt of 34 In. 1 In.	Maſt of 32 In. 2 In.	Maſt of 30 In. 3 In.	Maſt of 29 In. 4 In.	Maſt of 28 In. 5 In.	Maſt of 27 In. 6 In.	Maſt of 26 In. 7 In.	Maſt of 24 In. 8 In.	Maſt of 23 In. 9 In.	Maſt of 19 In. 10 In.	Maſt of 13 In. 11 In.	Maſt of 12 In. 12 In.
Pendant of Tackles	8½	8	7	6½	6	5½	5	7	6	5	4	4
Runners	6	5½	5	5	4½	4	3½	5	5	4½	3½	3½
Falls of the Tackles	4	4	3½	3½	3	3	3	3½	3½	2½	2½	
Shrouds	8½	8	7½	7	6½	5	5	7	6	5	4	4
Lanyards	4½	4	4	3½	3	3	3	4	3½	3¼	2½	2½
Swifters	8½	8	7½	7	6½	5	5	5½	5	4½	3½	
Lanyards	4½	4	4	3½	3½	3	2½	3½	3	3	2½	
Stay	17	16	15	14½	14	10	8	12	11½	9½	6½	6
Collar at the Stem	16	15	13	12	11	9	8	10	10	8	6	
Lanyard of the Stay	6	5½	5½	5	4	4	3½	4	4	3½	2½	3
Lifts	4½	4	3½	3½	3	3	2½	3	3	2½	2½	2
Tacks	9½	9	8½	8	6½	6	5	6½	6	5½	4	4
Sheets	6½	6½	6	6	5	4½	4	4½	4½	3½	2½	3
Bow-lines	5½	5	4½	4½	4	4	3	3	3	2½	2½	2½
Bridles	4½	4½	4	4	3½	3½	3	3	3	2½	2	
Pendants Fore-braces	4	4	3¾	3½	3	3	2¾	3	3	2½	2	2½
Braces	3	3	3	3	2½	2½	2	2½	2½	2	1½	2
Clew-garnets	4	3½	3	3	2½	2½	2	3	2½	2½	1½	2
Jeers	8½	8	7	6	5½	5		6	4½	4		
Parrel-rope	6	6	5	5	4½	4	3	4½	4	3½	3	3
Breaſt-rope	8	7	6	6	5							
Runner of Mart-lines	2½	2½	2½	2½	2	2						
Fall of Mart-lines	3	2¼	2¼	2	2	2		2½	2	2	1½	
Pendant of the Garnet	8½	8	7½	7	6	5	4½	6	5½	5	5	4
Tye	6	5½	5	5	4½	4	3½	3½	3½	3	3	3
Fall of the Garnet	4½	4	4	4	3½	3½	3	3	3	2¼	2	2

Note, Their Bunt-lines are in Bigneſs as followeth,

3½ 3½ 3 2½
2 2 2 2
2 2 2 2½

Note, The Ships that have no Jeers their Tye is 4 Inches, and their Hallyards is 2½.

Main-top-maſt Rigging	1	2	3	4	5	6	7	8	9	10	11	12
Pendant of Tackles	5	5	4½	4	3½	3	2¾	3½	3½	2½		2
Falls of Tackles	2½	2½	2½	2½	2	2	1½	2	2	1½		1½
Shrouds	5	5	4¼	4	4	3	3	4	3½	3	2¾	2½
Lanyards	2½	2½	2¼	2	2	2	1½	2	2	1½	1	1
Back-ſtays	5	5	5	4	3½	3	2½	4	4	3½	2	2½
Lanyards	3	3	3	2½	2½	2	2	2½	2	1½	1	1
Stay	8	7	6	5	5	4½	4	5	4½	3½	3	2½
Lanyard	4	4	3	3½	3	3	2¾	3	2½	2	1½	2
Lifts	2½	3	2½	2½	2	2	2¾	2	2	1½	1	1

The Bigneſs of Fore Rigging	1	2	3	4	5	6	7	8	9	10	11	12
Pendants of Tackles	8	7½	7	6	5	5	5	6¼	5½	4½	3½	6
Runners of Tackles	5½	5	5	5	4	4	4	5	5	4½	3	2½
The Falls	4	3½	3½	3½	3	3	3	3½	3	2½	2	
Shrouds	8	7½	6½	6	5½	5	4½	6	5½	4½	3½	3½
Lanyards	4	4	4	4	3½	2½	2	3½	3½	3	2	2
Swifters	8	7½	7	6	5½	5	4½					
Lanyards	4	4	4	4	3½	3½	3					
Stay	15	13	12	11	9	7	6½	10½	8½	7½	5	4
Lanyard	5	5	5	4½	4	3½	3	4	3½	3	2	2
Tye	8	7½	7	7	6	6	5	5½	5	5	3½	4
Hallyards	6	6	6	5	4½	3½	3	3	3½	3	2	2
Jeers	6½	6	6	6	4	4	5½					
Lifts	4	3½	3½	3[illegible]	3	2½	2	3	3	2½		2
Parrel-ropes	5	5	4½	4½	4	4	3	3	3	2½	2	2½
Breaſt-ropes	8	7	6	6½	5							
Sheets	6	6	5	5	4½	4	3½	4½	4	3½	2½	2½
Jacks	8½	8	7	7	6	5	4½	6	6	5	5	3½
Bow-lines	4½	4½	4	3½	3½	3	3	3¼	3	2½	2	2½
Bridles	4½	4	3½	3	3	3	2	3½	3	2½	2	2
Pendants of Braces	4	3½	3	3	2½	2½	2½	3	3	2½	1½	2
Braces	3	3	2½	2½	2	2	2	2½	2½	2	1¼	1½
Clew-garnets	3½	3	3	2½	2	2	2	3	2½	2	1½	1½
Bunt-lines	3	3	2½	2½	2	2	2	2	2	2	1½	1½
Mart-line Runners	3	2½	2½	2½	2							
Mart-lines	2½	2½	2½	2½	2	2½	2	2	1½			

The Bigneſs of the Fore-top-ſail Rigging.	1	2	3	4	5	6	7	8	9	10	11	12
Pendants of Tackles	4½	4	3½	3	2½	2½	3½	3½	3	2½		
Falls to them	2½	2	2	2	1½	1½	2	2	2	1½		
Shrouds	4½	4	3½	3½	3	3	2½	4	3	3	2	2
Lanyards	2	2	2	2	1½	1½	2	2	1½	1½	1	1
Puttocks	5	4½	4½	4	3½	3	2¾	3	3	2½	1½	
Stay	5	5	5	4½	4	3	3	4½	4	3½	2	2½
Pendant of the Lanyard	4	3½	3½	3	2½	2½	1¾					1½
Fall of the Lanyard	3½	3½	3	2½	2	2	2	3	2½	2	1½	1½
Tye	7	7	6½	6½	5½	5	5	6	5	3½	2	
Runner	5	5	4¾	4¾	4	4	4	4½	4	3½		
Hallyards	5	4½	4	4	3½	3½	2¾	3	2½	2	1½	
Bow-lines	4	3½	3	3	2½	2½	2½	2	2	1½	1¾	
Bridles	3½	3½	3	3	2½	2	1½	2	1½	1½	1½	
Clue-lines	4¼	4	4	3½	3	2½	2	3	2½	1½	1½	
Parrel-rope	4	4	4	3	3½	3	2	3½	3	2½	2¾	

The Bigneſs of the Bow-ſprit Rigging.	1 Maſt of 34 In. 1 In.	1 Maſt of 32 In. 2 In.	1 Maſt of 30 In. 3 In.	1 Maſt of 29 In. 4 In.	1 Maſt of 28 In. 5 In.	1 Maſt of 27 In. 6 In.	1 Maſt of 26 In. 7 In.	1 Maſt of 24 In. 8 In.	1 Maſt of 23 In. 9 In.	1 Maſt of 19 In. 10 In.	1 Maſt of 13 In. 11 In.	1 Maſt of 12 In. 12 In.
Pendants of Sheets	6	6	5½	5½	4½	4	3½	5	4½	4	3	2½
Sheets	4½	4½	4	3	3	2½	2½	4	3½	3¼	3	1½
Clew-lines	3	3	3	2½	2	2	2	3	2½	2	1½	1½
Garnets	3½	3	3	3	2½	2½	2	3	3	2½	1¾	
Pendants of Braces	4	4	3	3	2½	2½	2½	3	2½	2	1¾	1½
Braces	2½	2½	2½	2½	2	2	2	2½	2	1¾	1¾	1½
Hallyards	4½	4	3½	3½	3½	3	2¼	3½	3	2¾	2½	2
Tye	7	6	6	6	5	4½	4	6	5	5	4½	2
Bunt-lines	3	3	2½	2½	2	2	1½	2½	2½	2	1½	
Hoſſe	6	6	5½	5½	5	4	3	3	3	3	2½	2½
Lifts	4	3	3	3	2½	2	2	3	3	2½	2	1½

The Bigneſs of the Sprit-ſail-top Rigging.	1	2	3	4	5	6	7	8	9	10	11	12
Shrouds	3	3	2½	2½	2	2	1½	2½	2¼	2	1½	1
Lanyards	2	1¾	1¾	1½	1	1	1	2	1½	1	1	1
Pendants of Braces	2½	2½	2	2	1½	1½	1½	2	1¾	1½	1½	1
Braces	2	1½	1½	1½	1½	1	1	2½	1	1	1	1
Tye	3	3	3	2½	2	2	1½	1	1½	1½	1¼	1
Hallyards	2	2	2	2	1½	1½	1½	2	1½	1¾	1	1
Clew-lines	2½	2	2	2	1½	1½	1	2	1½	1½	1	1
Pendants of Tackles	3	3	3¼	2	1½	1½	¾	1½			¾	
Falls to them	2	2	1¾	1½	1	1	1					
Lifts	2	2	1½	1½	1½	1½	1	1¼	1½	1	1	1
Puttocks	3	3	2½	2	2	2	2	2½	2	2	2	1
Parrel-ropes	2	2	2¾	1½	1½	1½	1	1¾	1½	1½	1	1

The

The Bigneſs of the Mizen Rigging.	1 Maſt of 34 In.	1 Maſt of 32 In.	1 Maſt of 30 In.	1 Maſt of 29 In.	1 Maſt of 28 In.	1 Maſt of 27 In.	1 Maſt of 26 In.	1 Maſt of 24 In.	1 Maſt of 23 In.	1 Maſt of 19 In.	1 Maſt of 13 In.	1 Maſt of 12 In.
The Mizen-Maſt.	1 In.	2 In.	3 In.	4 In.	5 In.	6 In.	7 In.	8 In.	9 In.	10 In.	11 In.	12 In.
Pendants of Tackles-	5½	5	4½	4								
Runners	4	3½	3½	3								
Falls of Tackles	3	3	2½	2½								
Shrouds	5½	5	4¾	4½	3½	3	2½	4	4	3	2	2½
Lanyards	3	2½	2½	2½	2	2	1½	2	2	1½	1½	1½
Tye	7	6½	6	5	5	4½	4					
Hallyards	5	4½	3½	3	2½	2½	2	3½	3	2½	2	
Stay	6	5	4	3½	3½	3½	3	4	4	3	2½	2½
Lanyards	3½	3	2½	2½	2	2	1½	2½	2	1½	1	1½
Sheet	4	3½	3	2½	2½	2½	2	3	3	2½	2	1½
Jeer	5½	5	4	3½	3½							
Truſs	3½	3	2½	2½	2	2	1½	2½	2	2	1½	
Bow-lines	4	3	2	2	2	2	1¾	2½	2	1½	1½	1½
Brayles	2½	2	2	2	2	2	1½	2	1¾	1½	1½	1
Parrel-rope	5½	5	4	3	3	3	2½	3½	3	2½	2	2

The Croſs-jack.	1	2	3	4	5	6	7	8	9	10	11	12
Lifts	4	3½	2½	2½	2	1½	1	2½	2½	2	1½	1
Braces	2½	2½	2	2	1½	1	1	2	1¾	1½	1	1
Pendants	3½	3	2½	2¼	2	1½	1¼	2	1½	1¼	1	1
Hallyards	4	3½	3	3	2½	2	1½	2	1¾	1½	1½	1½

Bigneſs of Mizen-top-moſt Rigging.	1 *Maſt of* 34 *In.* 1 In.	1 *Maſt of* 32 *In.* 2 In.	1 *Maſt of* 30 *In.* 3 In.	1 *Maſt of* 29 *In.* 4 In.	1 *Maſt of* 28 *In.* 5 In.	1 *Maſt of* 27 *In.* 6 In.	1 *Maſt of* 26 *In.* 7 In.	1 *Maſt of* 24 *In.* 8 In.	1 *Maſt of* 23 *In.* 9 In.	1 *Maſt of* 19 *In.* 10 In.	1 *Maſt of* 13 *In.* 11 In.	1 *Maſt of* 12 *In.* 12 In.
Pendant of Tackless-	3½	3	2½	2½								
Falls of Tackles	2½	2¼	2	2								
Shrouds	3	3	2½	2½	2	1½	1	2	2	2		
Lanyards	2	1½	1½	1½	1½	1	1½	1	¾			
Puttocks	3½	3	2½	2½	2	1½	2	1½	1½	1		
Pendants of Braces --	2½	2½	2	1½	1½	1½	1	2	1½	1¾		
Braces	2	2	1¾	1½	1	1	1	1	¾			
Bow-lines	2½	2	1¾	1½	1¼	1	1	1½	1	¾		
Bridles	2	2	1½	1¼	1	1	1	1	1	¾		
Clew-lines	2	2	1¾	1½	1½	1½	1	2	1½	1½	1	1
Tye	3	3	3	2½	2½	2½	2	3	2	2	2	1½
Hallyards	2½	2½	2	2	1½	1½	1¼	2	1½	1½	1½	1
Lifts	2	2	1¾	1½	1½	1½	1	1	1	1	¾	1
Parrel-rope	3	2½	2	1¾	1½	1¾	1½	2	1½	1½	1	1
Runner of the Stay --	2½	2½	2									
Pendant of the Stay -	3	3	2¼	2	1½							
Top-rope	3¼	3½	3½	2½	2	2	1½					
Parts of the Stay	2	2	1½	1½	1	1	1					
Pendant forBackſtays	3	2½	2½									
Falls	2½	2	3¾									

The

The Bigneſs of the Main Top-gallant Rigging.	*Mast of 34 In.* 1 In.	*Mast of 32 In.* 2 In.	*Mast of 30 In.* 3 In.	*Mast of 29 In.* 4 In.	*Mast of 28 In.* 5 In.	*Mast of 27 In.* 6 In.	*Mast of 26 In.* 7 In.	*Mast of 24 In.* 8 In.	*Mast of 23 In.* 9 In.	*Mast of 19 In.* 10 In.	*Mast of 13 In.* 11 In.	*Mast of 12 In.* 12 In.
Pendants of Tackles	3	3	2½	2	2	2	2					1½
Fall of Tackles	2½	2	3¾	3½	3	3	1¾					1½
Shrouds	3	3	3¾	3½	3	3	1¾	2	2	1¾	1½	1
Lanyards	1¾	1½	1½	1½	1½	1½	1	1	1	1	1	1
Puttocks	3½	3	2½	2	2	2	1½	1½	1½	1	1	1
Pendants of Back-ſtays	3	3	2½	2	2	2						
Falls to them	2	2	1½	1½	1	1						
The Stay	3	3	3	2½	2	2	1½	2	1½	1	1	1
Lanyard	2½	2½	2½	2	2	2	1½	1¾	1¼	1	1	1
Braces	2	1½	1¼	1¼	1¼	1	1	1	1	¾	¾	¾
Pendants of Braces	2½	2½	2	2	1½	1½	1	1	1	1	1	1
Bow-lines	2½	2	1¾	1½	1½	1½	1	1	1	¾	¾	¾
Bridles	2	1½	1¼	1¼	1	1	1	1	1	¾	¾	
Top-rope	4½	4	3½	2½	2	2						
Parrel-rope	2½	2	2	2	1¾	1½	1	1½	1	1	1	1
Tye	3	3	3	2½	2½	2	1¾	2½	2	2	1¾	1¼
Hallyards	3	2½	2	2	1¾	1½	1	1½	1½	1	1¼	1¼
Lifts	2½	2	1½	1½	1	1	1	1	1	1	1	1
Flag-ſtaff-ſtay	2½	2	1½	1½	1	1					¼	
Clew-lines	2	2	1¾	1½	1½	1	1	1½	1½	1¼	1	1

The Bigneſs of the Fore-top-gallant Rigging.	1 *Maſt of* 34 *In.* 1 In.	1 *Maſt of* 32 *In.* 2 In.	1 *Maſt of* 30 *In.* 3 In.	1 *Maſt of* 29 *In.* 4 In.	1 *Maſt of* 28 *In.* 5 In.	1 *Maſt of* 27 *In.* 6 In.	1 *Maſt of* 26 *In.* 7 In.	1 *Maſt of* 24 *In.* 8 In.	1 *Maſt of* 23 *In.* 9 In.	1 *Maſt of* 19 *In.* 10 In.	1 *Maſt of* 13 *In.* 11 In.	1 *Maſt of* 12 *In.* 12 In.
Tye	2½	2½	1¾	1½	1½	1½	1¼	2½	2	1½	1¼	1¼
Hallyards	2½	1½	1½	1	1	1	1	1½	1½	1	1	1
Bow-lines	2	2	1½	1½	1¼	1¼	1	1	1	¾		
Bridles	1¾	1½	1½	1½	1½	1¼	1	1	1	¾		
Stay	2½	2½	2	2	1¾	1½	1	1½	1½	1		
Shrouds	2½	2½	2	2	1½	1½	1	2	1½	1		
Lanyards	1½	1½	1½	1	1	1	1	1¼	1¾	¾		
Parrel-rope	2	2	1½	1½	1	1	1	1½	1½	1		
Clew-lines	2	1¾	1½	1½	1¼	1¼	1	1½	1½	1		
Braces	2	1½	1¼	1¼	1¼	1	1	1	1	¾		
Lifts	2	1¾	1½	1½	1¼	1	1	1	1	1		
Top-rope	3½	3	3	2½								
Pendant of Tackles	3	2½	1½									
Falls	2¼	2	2									
Puttocks	3	3½	2½	2	1¾	1½	1½	1	1	1	1	1
Back-ſtays	2½	2½	2									

Number

Number, Weight, and Size of ANCHORS and CABLES for a Ship of each Claſs.

		Anchors				Cables	
Rate.	Guns	Nº.	Weight of each. C.	q.	lb.	Nº.	Size of each. *Inches.*
1	100	5	77	3	0	9	23 ½
	Stream	1	20	0	0	1	14
	Kedge	1	10	0	0		
2	90	5	71	3	0	9	22 ½
		1	17	0	0	1	13 ½
		1	9	2	0		
3	80	4	65	3	0	8	21 ½
		1	16	0	0	1	13
		1	8	2	0		
	70	4	56	2	0	7	20 ½
		1	14	0	0	1	12 ½
		1	7	2	0		
4	60	4	51	2	0	7	19 ½
		1	12	0	0	1	11 ½
		1	6	2	0		
	50	4	46	2	0	7	18 ½
		1	11	2	0	1	11
		1	6	0	0		
5	40	4	37	3	0	7	17
		1	9	2	0	1	10
		1	5	0	0		
6	24	4	29	1	0	6	15 ½
		1	6	2	0	1	8
		1	3	0	0		
Sloops.		3	15	0	0	5	13
		1	7	0	0	1	8
		1	3	2	0		

A CORDAGE TABLE, *ſhewing how many Fathoms, Feet, and Inches of a Rope of any Size under* 14 *Inches, makes a Hundred Weight; with the Conſtruction of th Table, and Rules to calculate the Weight of Ropes to any larger Circumference.*

I.	*F.*	*F.*	*I.*	*I.*	*F.*	*F.*	*I.*	*I.*	*F.*	*F.*	*I.*
1	486	0	0	6	13	3	0	11	4	0	3
1/4	313	3	0	1/4	12	2	0	1/4	3	5	7
1/2	216	3	0	1/2	11	3	0	1/2	3	4	1
3/4	159	3	0	3/4	10	4	0	3/4	3	3	3
2	121	3	0	7	9	5	6	12	3	2	3
1/4	96	2	0	1/4	9	1	6	1/4	3	2	1
1/2	77	3	0	1/2	8	4	0	1/2	3	2	0
3/4	65	4	9	3/4	8	3	6	3/4	2	7	8
3	54	0	0	8	7	3	6	13	2	5	3
1/4	45	5	2	1/4	7	0	8	1/4	2	4	9
1/2	39	3	0	1/2	6	4	3	1/2	2	4	0
3/4	34	3	9	3/4	6	2	1	3/4	2	3	6
4	30	1	6	9	6	0	0	14	2	2	1
1/4	26	5	3	1/4	5	4	0				
1/2	24	0	0	1/2	5	2	0				
3/4	21	3	0	3/4	5	0	6				
5	19	3	0	10	4	5	0				
1/4	17	4	0	1/4	4	4	1				
1/2	16	1	0	1/2	4	2	2				
3/4	14	4	6	3/4	4	1	8				
6	13	3	0	11	4	0	3				

The Uſe of the Cordage-Table.

THE Letters *I. F. F. I.* at the Top of the Table ſignify *Inches*, *Fathoms*, *Feet* and *Inches*. The firſt Column being the Thickneſs of the Rope in Inches and Quarters, and the other three the Fathoms, Feet and Inches that make up an hundred Weight of ſuch a Rope. One *Example* will make it plain.

Suppoſe I deſire to know how much of a 7 Inch Rope will make an hundred Weight; find 7 in the fifth Column under *I*, or *Inches* thickneſs of the Rope, and againſt that, in the ſixth, ſeventh, and eighth Columns, you find 9 | 5 | 6; which ſhews, that (in a Rope of 7 Inches) 9 Fathom, 5 Feet, and 6 Inches, is required to make an hundred Weight. And ſo in a 9 Inch Rope, 6 Fathom makes an hundred Weight: And in a 3 Inch Rope, 54 Fathom makes an hundred Weight, *&c.*

The Conſtruction of this TABLE *is from hence.*

A Rope of 1 Inch about, requires 486 Fathom to make up an hundred Weight; and, as the ſuperficial Content of all Circles are in Proportion to the Squares of their Diameters, (and conſequently to the Squares of their Circumferences) it will follow, that as a Rope of 1 Inch in Circumference, whoſe Square is alſo 1, has 486 Fathom to an hundred Weight; 486 divided by the Square of the Circumference, or Girt of any other Rope, the Quotient will give the Number of Fathoms in an hundred Weight. As for *Example*: In a 9 Inch Rope 9 times 9 is 81, by which divide 486, the Quotient is 6, the Fathoms in an hundred Weight. And ſo for a 3 Inch Rope, 3 times 3 is 9, by which divide 486, the Quotient is 54 Fathom to an hundred Weight, as in the Table; and where there is a Fraction in the Diviſion, it may be reduced to Feet and Inches; 6 Feet being a Fathom, and 12 Inches a Foot.

A TABLE *ſhewing the Weight of any Cable or Rope of* 120 *Fathom in Length, and for every half Inch from* 3 *Inches to* 24 *in Circumference.*

I.	*C.*	*Q.*	*I.*	*C.*	*Q.*
3	2	1	14	49	0
3½	3	0	14½	52	2
4	4	0	15	56	1
4½	5	0	15½	60	0
5	6	1	16	64	0
5½	7	2	16½	68	0
6	9	0	17	72	1
6½	10	2	17½	76	2
7	12	1	18	81	0
7½	14	0	18½	85	2
8	16	0	19	90	1
8½	18	0	19½	95	0
9	20	1	20	100	0
9½	22	2	20½	105	0
10	25	0	21	110	1
10½	27	2	21½	115	2
11	30	1	22	121	0
11½	33	0	22½	126	2
12	36	0	23	132	1
12½	39	0	23	138	0
13	42	1	24	144	0
13½	45	2			

I choſe to inſtance in a Cable of the Length abovementioned, becauſe Yarn ſet at 200 Fathom, will, in the laying of a Cable, work up or ſhorten to 120 Fathom; Cable-laid Ropes working in about two Parts in five; but if it is a half Cable, or a Part of a Cable of any other Length, the Weight of 120 Fathom being found by the Table, the Weight of any leſſer Part is eaſily found in Proportion to its Length.

The

The Uſe of the TABLE.

THE firſt Column marked *I.* for *Inches*, is the Thickneſs or Circumference of the Cable to every half Inch from 3 to 24; the ſecond and third, marked *C. Q.* for *Hundreds* and *Quarters*, are the Hundreds and Quarters that it will weigh if 120 Fathom in Length. As for Inſtance, ſuppoſe a Cable of fourteen Inches and half; look againſt 14½ in the fourth Column, and you find againſt it in the other Columns 52|2; which ſhews that 120 Fathom of Cable of 14 Inches and an half about, will weigh 52 Hundred 2 Quarters, or 52 Hundred and an half; and ſo in others. And any of a leſſer Length will weigh in Proportion.

The Conſtruction of this Table is from hence, that as all Cables are ſolid Bodies, and may properly come under the Denomination of Cylinders; and as ſuch, the Weight of Cables of any determinate Length, will be in proportion to the Squares of their Circumferences. From this Foundation, Experience has formed this general brief Rule, *viz. Multiply the Thickneſs of the Cable by itſelf, and one Fourth of that Product is the Weight of* 120 *Fathom.* As for Inſtance; ſuppoſe a Cable of 12 Inches, 12 times 12 is 144, the Quarter of which is 36, the Weight of 120 Fathom of a Cable of 12 Inches; as you ſee in the Table.

Note, This Table gives the utmoſt Weight of Cables of the Length and Size propoſed, and ſomething, tho' inconſiderably, differs from the foregoing. As for Inſtance; in the foregoing Table 6 Fathom of a 9 Inch Rope makes an Hundred Weight, and conſequently 120 Fathom ſhould be juſt 20 Hundred Weight, but in this it makes 20 Hundred and 1 Quarter; but the Difference is inconſiderable, and the Cables never exceed the Weight here propoſed.

Directions for cutting out SAILS.

HAving made a Scale, by which the Length of the Keel, &c. is laid down, you may obſerve the following Directions.

Fix two Yards, the one hoiſted, the other lowered, or a Portlings; the Top-ſail Yard alſo, the one hoiſted, the other down upon the Cap, and thus muſt you do in all the Models you raiſe.

The Yard a Portlings gives the Length of the Top-ſail Sheets, Lifts, Tye or Jeers, Bunt-lines, and Leech-lines or Hallyards, meaſuring from the Hounds to the Deck.

The Yards hoiſted gives the Length of the Clew-lines, Braces, Clew-garnets, Jacks, Sheets, and Bow-lines.

You may alſo find the Length of the Shrouds, Top-ſail Hallyards, Braces, and Lifts.

You may alſo, from a Model thus raiſed, give a near Eſtimation how many Yards of Canvas is in a Main Courſe. *Note*, When you come into any Ship or Veſſel, and deſire to know how many Yards of Canvas are in the Main or Fore Courſe: Firſt, find the Depth of your Sail, and the Breadth of the Canvas made uſe of, then take off ſo much from the Scale as you ſee the Cloth is in Breadth, and place ſo many Cloths in the Model, on the Main or Fore Yard, the ſame Depth that the Sail is on. After you have ſo done, take a Fathom or two off from your Scale, and meaſure every Cloth up and down, as you do the Ropes, and that will give you the Yards.

You may alſo, from ſuch a Model, find the Number of Yards that are in the Main or Fore Top-ſail: The ſame way you meaſure one Sail, you meaſure all.

But you muſt obſerve, that you are to place the middle Cloth firſt in a Top-ſail, and ſo from thence to each Yard-arm, that your Gores at the Clew may fall out right.

It likewiſe ſheweth the Length of the Main-top-ſail Bow-lines, and of the Fore-top-ſail Bow-line. Draw only a Line from the Top-ſail Yard-arm, to the Main Yard-arm, with Ink or Black-lead. *Note*, From the further Yard-arm, that you may take them at the largeſt Extent, and ſo your Braces. You alſo have the Length of the Main Bow-line, Main Sheet, Main Jack, and ſingle Garnet.

As for Braces, draw a Line from the Yard-arm to the Place where the Brace ſhould go: You may draw it double, if you pleaſe, as the Braces go; or you may draw but one ſingle Line, and ſo take a Fathom off from your Scale, and where it goes double, tell two Fathom, where Single tell but one.

And for the Fore-top-ſail Sheets, draw a Line from the Top-ſail Yard that is upon the Cap, down to the Yard-arm that is a Portlings; then take one Fathom or two off your Scale, and meaſure from the Top-ſail Yard to the Fore Yard upon the Line that you have drawn, and then from the Fore-yard-arm to the Maſt, and ſo down to the Forecaſtle, and there you have the juſt Length of your Top-ſail Sheets, and it is left to your Diſcretion what Stay you will allow: So likewiſe you muſt do for your Main-top-ſail Sheet, Fore-top-gallant Clew-lines, and Top-ſail Clew-lines; as alſo for any Ropes whatſoever, drawing the Lines, and meaſuring their Lengths.

But *Note*, That when you meaſure the Stays, you muſt meaſure the Collar firſt double three or four Fathom, according as your Model requires it; for as it becomes the Model, ſo it will appear upon the Veſſel, and obſerve that the Collar belongs to the Length of the Stay.

But for the Pendants of the Braces, you muſt meaſure them firſt three, or two Fathom, as you ſee it will become the Model, there mark the Block, and ſo meaſure the Length of the Brace from that.

AN EXPLANATION OF THE PRINCIPAL TERMS Uſed in this TREATISE.

A

AFT, the after or hinder Part of the Ship, from the Midſhips to the Stern.

Apron of the Stem, a Part brought on upon it to faſten the Butt ends to; or a falſe Stem.

B

BACK, the middle Part of crooked Timber, being outward.

Back-ſtay, that which ſtops the aft Part of the Maſt.

Beams, are large pieces of Timber, laid acroſs the Ship; their Ends are lodged on the Clamps, and being bound by Knees to the Side, keep the Ship to her Breadth.

Bearding, the working of one Part of a Plank or Piece of thiner than the other.

To Belay, to faſten; ſo as may be eaſily looſed again, if requiſite.

Belly, the oppoſite to the *Back*, or the inſide of the middle Part.

Bend of Moulds, or a *whole Suit*; one of every ſort.

Bend of Riders, one of a ſort of each Side.

Beſt Bower Anchor, the biggeſt Anchor that hangs at the Bow.

Bevelling, when any Piece of Plank or Timber is not to be wrought Square, but in the Nature of a Rhombus.

Bills, the Ends of ſuch crooked Timber.

Birthing, the working up a Ships-ſide, or Bulk-head, &c.

Bit-pin, Pieces of Timber, to which the Ship's Cables are faſten'd

Blocks, ſometimes hard knotty Timber to lay under a Ship; otherwiſe the Timbers into which the Ropes are reeved, as Pulleys. We call it *Block and Block*, where two Blocks are haled together, and the Power or Purchaſe diſcontinued.

Bluffneſs, blunt, or full-bodied.

Bollow, the oppoſite to *Hollow*. The Ship is taken at the Edges, as if it was to be laid, or ſaid, in a Hollow.

Bolts, the Iron Pins, which faſten one Part of a Ship to another.

Bolt-Rope, a Bar for the Canvas in every Sail.

Bow, the round Part of a Ship forward without Board, ſo called from *Bowſe Ho*, a Watch-word for all the Men haling a Rope to hale together. That within is termed the *Breaſt*.

Brackets, generally carved Figures for Ornament.

Breaſt-hooks, large Knees fitted to the foremoſt Part within.

Breaſt Back-ſtay, that which is placed at the Side of the Maſt, ſtopping the fore Part as well as the aft.

Breaſt of a Ship. See *Bow*.

Breech, the outward Bending of Knee Timber.

Bulge, the outermoſt and loweſt Part of a Ship, that which ſhe bears upon when ſhe lies on the Ground.

Bulge-way, a Piece of Timber placed on each Side upon the Bulge, to ſlide a Ship into the Water.

Bulk-heads, the Partitions in a Ship.

Butt, both Ends of every Plank; but in the ſtricteſt Senſe the ground End, or the biggeſt End of all Timber.

Buttock, the after or hinder Part of a Ship from the Water to the Gun-room Port.

C

Camber. See *Snying*.

Canting, the turning of Plank or Timber, from one Side to another, in order to ſee the Defects, or for any other Purpoſe.

Carlings, are ſquare pieces of Timber, lying fore and aft, from one Beam to another, into which they are ſcored.

Cathead, a large ſquare piece of Timber; one End of it is faſtened upon the Fore-caſtle, the other End projects without the Bow, ſo far as to keep the Anchor clear of the Ship, when it is heaving up by a Tackle.

Catting the Anchor, is haling the Stock up to the Cat-head.

To Chamfer, to take off the ſharp Edge from any ſquare Piece.

Channels, Pieces of Plank fixed Edge-ways againſt the Ship's Side, making very near a Right-Angle with it.

Chine, that Part of the Water-way, or any thing that is channel'd, which is thicker than the other Part.

Chok, a ſmall piece of Timber fitted to a larger to make out the Subſtance required.

Clamps, Pieces, or Strakes of thick Plank on the Inſide, as the Wales are on the outſide of the Ship.

Cock-pit, two Places under the lower Deck, leading to the Store-Room.

Counter, a Part projecting the Stern from the Buttock.

Croſs-paled, Pieces nailed a-thwart the Ship to every Frame Timber.

Croſs-pieces, fitted a-croſs the Bit-pins, to which the Cables are belayed.

Crutches or *Clutches*, large Knees fitted in the Aft part of the Ship in Hold, to bind the Parts together.

D

Dagger Knees, ſuch as are placed at ſome certain Angle between a Perpendicular and the Horizon; the lodging Knees lying near Horizontal, and the hanging Knees Perpendicular.

Dead-Eyes, Pieces having three Holes through, in which the Lanyards of the Shrouds are reeved.

Dead-Wood, the Parts lying upon the Keel abaft and afore, which being covered both within and without, lie hid as if they were buried.

Decks, the Plans or Platforms in a Ship, as Stories or Floors in a Houſe

Deep-Load-mark, the Horizontal Parallel of the Surface of the Water, when the Ship has every thing aboard that ſhe is to carry.

Dove-tail, a Score or Notch cut bigger within than without, for holding faſt.

Draught, the Model or Figure of a Ship, or any of her Parts, deſcribed upon Paper.

Draught of Water, the Perpendicular Feet which the Ship has under the Water

Drifts, Parts projecting upwards, as far as certain Heights are thought proper to be continued.

Druxy, Plank or Timber decayed and ſpungy.

To Dub, to work with an Addice.

E

TO *Eek*, to fit a Part for the faſhioning out another more material, as in the Supporter of the Cat-head, and the Cheeks of the Head, where the *Eeking* is only applied to continue the Shape and Faſhion of the Part, and for little other Service.

Edging of Plank, hewing them narrower, according to the Uſe required.

F

FAlſe Keel, a ſort of Covering for the principal Keel.

Faſhion-pieces, two Pieces made exactly alike, and placed one of each Side the Buttock of the Ship, to make both Sides equal and alike.

To Fay, to join pieces of Timber cloſe together.

Firs, ſmaller Pieces than Choks, but to anſwer the ſame Deſign, in ſupplying the Wants that may happen in ſome Parts of the Ship.

Fiſhing the Anchor, haling the Flooks out of the Water.

Flairing, over-hanging upwards.

Floor-timbers, the Timbers in the Bottom of the Ship.

Fore, the Fore part of a Ship from the middle forward.

Fore-caſtle, a Place fitted for a cloſe Fight on the upper Deck forward.

G

GAſkets, Rope Yarn weaved to make the Sail faſt when it is furled, or bundled up to the Yards.

Ground-ways, large Pieces of Timber lying a-thwart the Bottom of a Dock, or Launch, to make the Foundation firm and ſubſtantial

H.

HAled home, when the Top-ſail Sheets are haled to their Places as far as they can be.

Hanging, the oppoſite to *Snying*, when the middle of the Plank appears lower than the Planks, but circular.

Harpings, the foremoſt Wale-pieces.

Hawſe-pieces, are broad Timbers in the Bow of the Ship, thro' which there are holes cut for the Cables to paſs.

Head of a Ship, that part which is faſtened to the Bow or foremoſt part of the Ship without Board; it is often carved as an Ornament to the fore part of the Ship.

Heel, the lower part of a Maſt, or any Timber.

To Heave, to hale or pull by turning round the Capſtan.

Hold of a Ship, the part under the lower Deck.

To Hollow, is ſlenderly to gutter a Plank, or any part, that the Edges may fay well.

Hoodings-ends, the Butt-ends in the Rabbits of the Stem and Stern-poſt, which are more hid by the Rabbits than the other But-ends are.

Hooking, the hitching one Plank into another for ſtoping them.

Horſes for the Yard, Ropes made faſt for the Men to ſtand upon in furling the Sails.

I

JUry Maſts, ſuch as can be got for hoiſting the Sails on, when the principal Maſts are loſt.

K

KEdge-Anchor, is the ſmalleſt of all, and generally uſed to warp or hale a Ship from one Place to another.

Keel, the principal piece of Timber firſt laid on the Blocks, which ſupports the whole Structure.

Keelſon, a large piece of Timber, raiſed over the Floor Timbers, and bolted through them into the Keel.

Kevels, ſmall pieces of Wood for belaying the Braces, and Ropes of a ſmaller Denomination than the Sheets. And as the Ranges are made in one large Piece of Timber, ſo the Kevels are made in three Pieces.

Knee, a crooked Piece of Timber that has one Branch cut off at the Bending, and the other remaining makes the Bend or Knee Timber.

L

LAnyard, a ſmall Rope, which faſtens a great one, for the conveniency of being reev'd in Holes and haled taught.

Lapſided, when a Ship ſwims to one Side more than the other, and her Decks are not level to the Horizon.

To Launch, to lower or ſlide a Ship off from the Land into the Water; likewiſe to leave off pulling, haling, or heaving.

Lazeretto, a Place on board of a Merchant Ship, for the Conveniency of the Commander, as Store-rooms are on Board of Men of War, to lay up the Proviſions and Neceſſaries for the Voyage.

To let fly, to let go, caſt off, or looſe any Rope at once, without Stopping. And when a Rope is ſo looſen'd, 'tis ſaid to be *flown*.

Limber-boards, are ſhort pieces of Plank, fayed next to the Keelſon, which may be taken out to clear the Limber-holes, that are left either below, or above the Floor-timbers, for a paſſage for the Water to the Pump.

To Line, to cover one Piece with another; alſo to mark out the Work with a ſmall Line chalked.

Load-mark Line, the Horizontal Line at the Surface of the Water.

Loof; the aft part of the Bow of a Ship between the Stem and the Midſhips.

M

MIdſhips, 'tis generally meant of all the Ship, from the Main Maſt to the largeſt part of the Ship, where the Midſhip Flat, or Midſhip Floor-timber lies.

N

NOG, a Trenel drove in at the Foot of each Shore, or the Props that ſupport the Ship in the Nature of trigging the Shores.

O

OVerlaunching, ſplicing or ſcarfing one Piece of Timber to another, to make firm Work.

P

Partners, Pieces fixed to ſteady the Maſts and Capſtans, having a Hole through each to receive the ſame.

Paunch, thrum'd Mats, much for the ſame purpoſe as Puddening.

Planſheers, the finiſhing part at the Top of the Ship-ſide, which ought to lie direct and level.

To Plum, to hew any Piece downright, or perpendicular.

Plummet, a Weight hanging by a Line to prove the Plumming.

Poop, the uppermoſt Deck abaft.

Preventers, Ropes that have Wale Knots at each End, chiefly uſed in Sea-fights. For when the Rigging is in part ſhot, ſuch Ropes are applyed to prevent the damaged Ropes being quite broke off.

Project, any thing that juts out in the Building; as of the Counter, Wales, *&c.*

To Pudden the Yards, to nail Pieces of old Rope round them, to preſerve them from galling.

Q

Quarter, the upper after Part of the Ship on the Outſide, and may be reckoned to commence from the middle of the Ship.

Quarter-pieces, large carved Pieces fixed to terminate the Quarter with the Stern.

To Quicken the Sheer, to ſhorten the Radius that ſtrikes out the Curve. Its oppoſite is ſtraitening the Sheer.

Quick-work, that part of a Ship's Sides both within and without Board, above the Channel-wales and Decks. 'Tis ſometimes performed with Deal, which don't require the faſtening, nor the Time to work it, as the other Parts, but is quicker done.

R

Rabbit, when a Plank is faſtened to any piece of Timber, ſuch as the Stem, or Poſt, there is ſo much Wood cut out of the Piece, as the Plank is thick, which is called a Rabbit.

Rails, are narrow Planks, generally of Fir, upon which there is generally a Moulding ſtruck. They are chiefly for Ornament, and nail'd a-croſs the Stern, above the Wing Tranſom and Counters.

Rake of the Stem and *Stern-poſt*, that part of the Ship's Hull that is extended fore and aft, from the ſtrait or horizontal Line of the Keel.

Ram-line, a Line made faſt at the Stem and Stern-poſt, hanging crooked by being weighted in the middle.

Ranges, Pieces fitted to the Ship to belay or faſten the Main and Fore Sheets.

To Reconcile, to make one piece of Work anſwer to the Uniformity of the other next to it, and more particularly in reverting of Curves.

Ribbonds, or *Rib-bands*, ſo called from binding the Ribs or Ship's Timber together.

Riders, Pieces fixed on the Inſide of the Ship on the In-board Plank, ſomething imitating the Ships Timbers or Ribs.

Rother, or *Rudder*, a Piece of Timber, or ſeveral Pieces faſtened together, and fitted to the Stern-poſt by Irons; the Ship is ſteered by it.

Rough Timber, that which is only cut down, and the Boughs lop'd off. Being hewed into Squares, 'tis ſaid to be *Rough-ſquared* according to the different Species.

Round-ſterned, to have ſharp or pointed Sterns, as Square Sterns are blunt and flat.

Runner, a ſingle Rope that runs or is haled in a Block.

S

SCantling, the Length, Breadth and Depth or Thickneſs of any part of the Ship, or pieces of Timber.

Seams, the Chinks into which the Oakum is drove between the Strakes of Planks.

To ſet Sail, to looſe the Sails, and manage them to the Wind.

To ſhorten Sail, is to hale ſome up in order to furl them.

Seaſoned Plank or *Timber*, ſuch as is thoroughly dry, and will not be apt to ſhrink.

Sheet-Anchor, bigger than either of the Bow-Anchors.

Shaken Plank or *Timber*, ſuch as is full of Clefts, and will neither bear calking nor faſtening.

Shank-painter, a Chain, or a large Rope, to ſecure the Anchor, and paſſed about the Shank of the Anchor.

Shifting Planks, the putting one But-end clear of another.

Sholes, Pieces of Slabs put under each Shore for the better ſecuring the Weight.

Shivering, when the Sail ſhakes, and is not filled with the Wind and bunted out.

Shrouds, Ropes that ſupport the Maſts.

Sir-mark, a particular Mark made to guide the Workman in placing the Parts.

Sleepers, thick Strakes of Plank lying fixed in the Bottom of the Ship.

Snying, an arching upwards, where the middle of a Plank appears higher than the Ends.

Sole of Planks, the flat Side of them.

Spirkit-riſing, the Plank fixed between the Decks and the Ports for raiſing up the Side within-board.

Standers, Knees fitted upon any of the Decks; alſo Pieces placed to raiſe Stages or Scaffolds.

To Steal, in Planking, is to have more Strakes in the middle of the Ship, than at the Stem or Stern-poſt.

Steaving, when a part riſes from an horizontal Poſition, as in the Cat-head, Bowſprit, and Knee of the Head.

Stem, the intire foremoſt part of a Ship.

Steps for the Maſts, large Pieces of Timber fitted at the Bottom of the Ship to ſteddy and ſecure the lower part of each Maſt, which is alſo called a Step.

Stern, the hinder or after part of a Ship, in which are all the Cabbin-lights.

Stern-poſt, that ſtrait piece of Timber at the after end of the Ship, which unites both the Sides; the Heel of it is tenanted into the Keel, and the Wing Tranſom faſtened at the Head of it.

Strake of Plank, one Breadth of ſuch Materials wrought either within Board, or without, from one End of the Ship to the other.

Stream Anchor, which ſtops the Ship in tiding up a River.

To Strike, to draw a Line, or delineate a Circle.

Strings, Parts uſed to ſtrengthen, and what are called Clamps in the lower Parts, are termed Strings upwards.

To Sweep, to deſcribe or mark out a Circle with any Inſtrument: And the Circle ſo marked out is generally called a Sweep.

T

T

TACK-piece, that to which the Fore-ſail is tacked down.

Taſting of Plank or Timber, chipping of it with an Addice to try the Defects.

Tackle Fall, the Rope that being reeved in Blocks or Pullies, is handed down to the Deck to be hal'd.

Taught or Tight, the ſtretching a Rope, that it may not hang ſlack or looſe.

Term-pieces, the finiſhing Pieces, or thoſe which terminate the Drifts.

Thick-ſtuff, all Plank (as it may be termed) which is thicker than 4 Inches.

Throat, the inward bending of Knee-timber.

Timbers, in a Ship, are as the Ribs in the Body, and ſerve to ſupport the Sides, the Planks being all faſtened to them; the two aftermoſt are called Faſhion-pieces, and ſupport the ends of Tranſoms.

Top-ſail a-trip, when 'tis hoiſted as high as it can.

Top-timbers, the uppermoſt Timbers in a Ship.

To trim a Ship, to load and equip her, and put her into a Condition for Sailing; alſo to caulk, clean, and dreſs a Ship, and do any ſmall matter in repairing her, or to fine-draw the Plank or Timber.

Tuck-ſquare, is, when the Heels of the Faſhion-pieces are let in upon the Poſts, at which place the Height of the Tuck is fixed.

Tumbling-home, when the Ship-ſide declines from a Perpendicular upwards, or, as ſome call it, houſes in.

V

VIol, a large Hawſer uſed to heave in the Cable.

W

WAke, or *Way*; the Bringing one part of a Ship too near another.

Wales, Pieces, or rather Strakes of thick Plank, by which the Ship is regularly ſheered or curved, and which alſo projects without the other Plank ſeveral Inches.

Wall-ſided, when the Ship's Side upward is built upright or perpendicular.

Waſte, that part of a Ship upon the upper Gun-deck between the Bulk-head of the Steerage and Fore-caſtle.

Water-ways, thick Plank channel'd or gutter'd, and fixed on the Decks next to the Ship's Side.

Within-board, within-ſide of the Ship; as *Without-board*, on the out-ſide.

Winding, when the Plank or Timber's Side or Edge is not upon a direct Plan, but ſeemingly twiſts.

Wood and Wood, when a Trenel is drove through, that the Point of it is directly with the Plain of the Plank through which 'tis drove.

Woulding, the binding about a Maſt, or the like, with Ropes.

Wrung-heads, that part between the Floor-timber Head and ſecond Foot-hook Heal, which, if a Ship lies on the Ground, bears the greateſt Strain.

FINIS.

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MAY